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Acoustic assessment and distribution of anchovy, sardine and chub mackerel in ICES Subdivision 9a South during the *ECOCADIZ 2020-07* Spanish survey (August 2020) with notes on the distribution of other pelagic species.

By

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ABSTRACT

The present working document summarises a part of the main results obtained from the Spanish (pelagic ecosystem-) acoustic survey conducted by IEO between 01st and 14th August 2020 in the Portuguese and Spanish shelf waters (20-200 m isobaths) off the Gulf of Cadiz (GoC) onboard the R/V *Miguel Oliver*. The 21 foreseen acoustic transects were sampled. A total of 26 valid fishing hauls were carried out for echo-trace ground-truthing purposes. Four additional night trawls were conducted to collect anchovy hydrated females (DEPM). This working document only provides abundance and biomass estimates for anchovy, sardine and chub mackerel, which are presented without age structure. The distribution of all the mid-sized and small pelagic fish species susceptible of being acoustically assessed is also shown from the mapping of their back-scattering energies. GoC anchovy acoustic estimates in summer 2020 were of 5153 million fish and 44 877 tones, with the bulk of the population occurring in the Spanish waters. The current biomass estimate becomes in the second historical maximum within the time-series. The estimates of sardine abundance and biomass in summer 2020 were 1923 million fish and 50 721 t, estimates close to the historical average, but lower than the values estimated last year and the most recent maxima reached in 2018. A total of 32 854 t and 448 million fish were estimated for Chub mackerel, estimates similar to the most recent ones and very close to the time-series average.

INTRODUCTION

The *ECOCADIZ* surveys constitute a series of yearly acoustic surveys conducted since 2004 by IEO in the Subdivision 9a South (Algarve and Gulf of Cadiz, between 20 – 200 m depth) under the "pelagic ecosystem survey" approach. The series started onboard R/V *Cornide de Saavedra* until 2013, since 2014 on onboard R/V *Miguel Oliver*. This series started in 2004 with the *BOCADEVA 0604* pilot combined acoustic - anchovy DEPM survey. The following surveys within this new series (named *ECOCADIZ* since 2006 onwards) are planned to be routinely performed on a yearly basis, although the series, because of the available ship time, has shown until 2014 some gaps in those years coinciding with the conduction of the triennial anchovy DEPM survey (the true *BOCADEVA* series, which first survey started in 2005).

Results from the *ECOCADIZ* series are routinely reported to ICES Expert Groups on both stock assessment (formerly in WGMHSA, WGANC, WGANSA, at present in WGHANSA) and acoustic and egg surveys on anchovy and sardine (WGACEGG).

The present Working Document advances some results from the *ECOCADIZ 2020-07* survey. These results will only refer to the size-based acoustic estimates and spatial distribution of anchovy, sardine and chub mackerel, and to inferences on the spatial distribution of other pelagic species from the distribution of the acoustic energy attributed to each of these species.

MATERIAL AND METHODS

The *ECOCADIZ 2020-07* survey was carried out between 01st and 14th August 2020 onboard the Spanish R/V *Miguel Oliver* covering a survey area comprising the waters of the Gulf of Cadiz, both Spanish and Portuguese, between the 20 m and 200 m isobaths. The survey design consisted in a systematic parallel grid with tracks equally spaced by 8 nm, normal to the shoreline (**Figure 1**).

Echo-integration was carried out with a *Simrad™ EK60* echo sounder working in the multi-frequency fashion (18, 38, 70, 120, 200 kHz). Average survey speed was about 10 knots and the acoustic signals were integrated over 1-nm intervals (ESDU). Raw acoustic data were stored for further post-processing using *Echoview™* software package. Acoustic equipment was previously calibrated during the *MEDIAS 2020* acoustic survey, a survey conducted in the Spanish Mediterranean waters just before the *ECOCADIZ* one, following the standard procedures (Demer *et al*., 2015).

Survey execution and abundance estimation followed the methodologies firstly adopted by the ICES *Planning Group for Acoustic Surveys in ICES Sub-Areas VIII and IX* (ICES, 1998) and the recommendations given by the *Working Group on Acoustic and Egg Surveys for small pelagic fish in NE Atlantic* (WGACEGG; ICES, 2006a,b).

Fishing hauls for echo-trace ground-truthing were opportunistic, according to the echogram information. Hauls PE01 to PE28 were carried out using a ca. 15 m-mean vertical opening pelagic trawl (*Tuneado* gear). At the end of PE28 the *Tuneado* gear suffered a serious breakage because a hooking with an undetected obstacle over the bottom. Fishing hauls PE29 and PE30 were carried out with a *Gloria HOD 352* pelagic trawl gear (ca. 10 m-mean vertical opening net). All the fishing hauls were performed at an average speed of 4-4.5 knots. Gear performance and geometry during the effective fishing was monitored with *Simrad™ Mesotech FS20* trawl sonar and a *Marport™ NBTE* (Narrow Band Trawl Eye) sensor. Trawl sonar and sensors data from each haul were recorded and stored for further analyses.

Ground-truthing haul samples provided biological data on species and they were also used to identify fish species and to allocate the back-scattering values into fish species according to the proportions found at the fishing stations (Nakken and Dommasnes, 1975).

Length frequency distributions (LFD) by 0.5-cm class were obtained for all the fish species in trawl samples (either from the total catch or from a representative random sample of 100-200 fish). Only those LFDs based on a minimum of 30 individuals and showing a normal distribution were considered for the purpose of the acoustic assessment.

Individual biological sampling (length, weight, sex, maturity stage, stomach fullness, and mesenteric fat content) was performed in each haul for anchovy, sardine, mackerel and horse-mackerel species, and bogue. Otoliths were dissected from anchovy, sardine and chub mackerel sampled specimens.

The following TS/length relationship table was used for acoustic estimation of assessed species (following recent IEO standards after ICES, 1998 and recommendations by ICES, 2006a,b. b_{20} values for transparent goby and Atlantic pomfret following to Foote, 1987 for physoclists):

Species	b_{20}
Sardine (*Sardina pilchardus*)	-72.6
Round sardinella (*Sardinella aurita*)	-72.6
Anchovy (*Engraulis encrasicolus*)	-72.6
Chub mackerel (*Scomber japonicus*)	-68.7
Mackerel (*S. scombrus*)	-84.9
Horse mackerel (*Trachurus trachurus*)	-68.7
Mediterranean horse-mackerel (*T. mediterraneus*)	-68.7
Blue jack mackerel (*T. picturatus*)	-68.7
Bogue (*Boops boops*)	-67.0
Transparent goby (*Aphia minuta*)	-67.5
Atlantic pomfret (*Brama brama*)	-67.5
Blue whiting (*Micromesistius poutassou*)	-67.5
Silvery lightfish/pearlside (*Maurolicus muelleri*)	-72.2
Longspine snipefish (*Macroramphosus scolopax*)	-80.0
Boarfish (*Capros aper*)	-66.2* (-72.6)

*Boarfish b_{20} estimate following to Fässler *et al*. (2013). Between parentheses the usual IEO value considered in previous surveys.

The *PESMA 2010* software (J. Miquel, unpublished) has got implemented the needed procedures and routines for the acoustic assessment following the above approach.

The *Continuous Underway Fish Egg Sampler* (CUFES) was not used in the survey since it was used in the previous *BOCADEVA 0720* anchovy DEPM survey. A *Sea-bird Electronics™ SBE 21 SEACAT* thermosalinograph and a *Turner™ 10 AU 005 CE Field* fluorometer were used during the acoustic tracking to continuously monitor some biological (ichthyoplankton and *in vivo* fluorescence) and hydrographical variables (sub-surface sea temperature and salinity). Vertical profiles of hydrographical variables were also recorded by night from 158 CTD casts distributed in 15 transects by using *Sea-bird Electronics™ SBE 911+ SEACAT* (with coupled *Datasonics* altimeter, *SBE 43* oximeter, *WetLabs ECO-FL-NTU* fluorimeter and *WetLabs C-Star 25 cm* transmissometer sensors) and *LADCP T-RDI WHS* 300 kHz profilers (**Figure 2**). *VMADCP RDI 150 kHz* records were also continuously recorded by night between CTD stations.

Information on presence and abundance of sea birds, turtles and mammals was also recorded during the acoustic sampling by one onboard observer.

RESULTS

Acoustic sampling

The acoustic sampling started on 01st August in the coastal end of the transect RA01 and finalized on 11th August in the oceanic end of the transect RA21 (**Table 1, Figure 1**). Transects were acoustically sampled in the E-W direction. The whole 21-transect sampling grid was sampled. The acoustic sampling usually started at 06:00 UTC although this time might vary depending on the duration of the works related with the hydrographic sampling.

Groundtruthing hauls

Twenty six (26) fishing operations, all of them being considered as valid ones according to a correct gear performance and resulting catches, were carried out (**Table 2**, **Figure 3**).

As usual in previous surveys, some fishing hauls were attempted by fishing over an isobath crossing the acoustic transect as close as possible to the depths where the fishing situation of interest was detected over that transect. In this way the mixing of different size compositions (*i.e*., bi-, multi-modality of length frequency distributions) was avoided as well as a direct interaction with fixed gears. The mixing of sizes is more probable close to nursery-recruitment areas and in regions with a very narrow continental shelf. This type of hauls is also conducted in depths showing hard and/or very irregular bottoms or when the echotraces to be identified either are very scarce or very located in the bathymetric gradient. Given that all of these situations were not very uncommon in the sampled area, 27% of valid hauls (7 hauls) were conducted over isobath.

Because of many echo-traces usually occurred close to the bottom, all the pelagic hauls were carried out like a bottom-trawl haul, with the ground rope working over or very close to the bottom. According to the above, the sampled depth range in the valid hauls oscillated between 36-191 m.

During the survey were captured 2 Chondrichthyan, 40 Osteichthyes, 3 Cephalopod, 1 Crustacean and 1 Cnidarian-Hydrozoa species. The percentage of occurrence of the more frequent fish species (sharks excluded) in the trawl hauls is shown in the enclosed **text table below** (see also **Figure 4**). The table includes all the species under study and also those species with a higher occurrence than the former ones. The pelagic ichthyofauna was the most frequently captured species set and the one composing the bulk of the overall yields of the catches. Within this pelagic fish species set, chub mackerel was the most frequent captured species (26 hauls, 100% presence index) followed by mackerel (23 hauls, 88%), anchovy (21 hauls, 81%), horse mackerel (20 hauls, 77%), bogue (17 hauls, 65%), sardine (15 hauls, 58%), blue jack mackerel (12 hauls, 46%) and Mediterranean horse mackerel (6 hauls, 23%). Round sardinella, longspine snipefish, Atlantic pomfret and transparent goby showed a very low occurrence (3 hauls, 12%), whereas the occurrence of boarfish and pearlside (1 haul, 4%) was incidental. Blue whiting was absent in the catches.

For the purposes of the acoustic assessment, anchovy, sardine, round sardinella, mackerel species, horse & jack mackerel species, bogue, snipefish, boarfish and pearlside were initially considered as the survey target species. All of the invertebrates, and both bentho-pelagic (*e.g.*, manta rays) and benthic fish species (*e.g*., flatfish, gurnards, etc.) were excluded from the computation of the total catches in weight and in number from those fishing stations where they occurred. Catches of the remaining non-target species were included in an operational category termed as "*Others*".

According to the above premises, during the survey were captured a total of 20.9 tonnes and 1.1 million fish (**Table 3**). 39% of this fished biomass corresponded to anchovy, 29% to chub mackerel, 23% to sardine, 3% to horse mackerel, and contributions lower than 3% to the remaining species. The most abundant species in ground-truthing trawl hauls was also anchovy (72%), followed by sardine (19%) and chub mackerel (8%), with the remaining species showing lower contributions than 0.3%.

Species	OCCURRENCE (Number of valid hauls)	OCCURRENCE (% over Total valid hauls)	Total weight (Kg)	Total number
Scomber colias	26	100,00 %	6124,053	92522
Merluccius merluccius	24	92,31 %	78,230	679
Scomber scombrus	23	88,46 %	54,274	390
Engraulis encrasicolus	21	80,77 %	8150,282	805650
Trachurus trachurus	20	76,92 %	300,078	3877
Boops boops	17	65,38 %	172,764	1297
Alosa fallax	16	61,54 %	24,489	94
Sardina pilchardus	15	57,69 %	4823,831	211225
Spondyliosoma cantharus	14	53,85 %	127,919	817
Trachurus picturatus	12	46,15 %	35,099	534
Pagellus erythrinus	9	34,62 %	91,251	539
Diplodus annularis	7	26,92 %	4,158	65
Trachurus mediterraneus	6	23,08 %	582,839	3015
Diplodus vulgaris	6	23,08 %	210,017	1437
Trachinus draco	5	19,23 %	1,470	11
Pagellus acarne	4	15,38 %	26,933	116
Diplodus bellottii	4	15,38 %	5,192	72
Sardinella aurita	3	11,54 %	70,874	379
Macroramphosus scolopax	3	11,54 %	8,250	1136
Brama brama	3	11,54 %	4,070	4
Pagellus bellottii bellottii	3	11,54 %	11,435	73
Aphia minuta	3	11,54 %	0,270	742
Spicara flexuosa	3	11,54 %	4,371	102
Pomatomus saltatrix	2	7,69 %	0,775	2
Chelidonichthys lucerna	2	7,69 %	0,315	2
Xenodermichthys copei	1	3,85 %	10,000	62
Maurolicus muelleri	1	3,85 %	0,081	67
Belone belone belone	1	3,85 %	1,405	2
Zenopsis conchifer	1	3,85 %	0,210	1
Capros aper	1	3,85 %	3,830	784
Mugil cephalus	1	3,85 %	1,750	1
Caranx rhonchus	1	3,85 %	0,565	4
Trachinotus ovatus	1	3,85 %	0,230	1
Pomadasys incisus	1	3,85 %	0,570	5
Pagellus bogaraveo	1	3,85 %	0,075	1
Diplodus puntazzo	1	3,85 %	0,360	1
Dentex gibbosus	1	3,85 %	8,765	1
Sparus aurata	1	3,85 %	0,815	2
Mullus surmuletus	1	3,85 %	0,120	1
Stromateus fiatola	1	3,85 %	0,775	1
Chelidonichthys obscurus	1	3,85%	0,09	1

The species composition, in terms of percentages in number, in each valid fish station is shown in **Figure 5**. A first impression of the distribution pattern of the main species may be derived from the above figure. Thus, anchovy was captured all over the surveyed area, although the highest yields were recorded in the between eastern Algarve and Spanish central waters. The size composition of anchovy catches confirms the usual pattern exhibited by the species in the area during the survey season, with the largest fish inhabiting the westernmost and easternmost waters and the smallest ones concentrated in the surroundings of the Guadalquivir river mouth and adjacent shallow waters (**Figure 5**). Sardine catches also showed widely distributed along the surveyed area, but showing the highest yields in three spots located in the surroundings of the Bay of Cadiz, central waters of the Gulf and Cape Santa María. The largest sardines were captured in the Portuguese waters whereas juvenile sardines were mainly captured in the shallowest hauls conducted in the coastal fringe between Tinto-Odiel river mouth and the Bay of Cadiz (**Figure 6**). Chub mackerel, horse mackerel, blue jack mackerel and bogue, although they occurred in a great part of the study area, only showed relatively high yields in the Portuguese waters. Conversely, mackerel recorded the highest yields in Spanish waters. Mediterranean horse mackerel was restricted to the central and easternmost Spanish waters. The size composition of these last species in fishing hauls is shown in **Figures 7** to **16**.

Back-scattering energy attributed to the "pelagic assemblage" and individual species

A total of 322 nmi (ESDU) from 21 transects has been acoustically sampled by echo-integration for assessment purposes. From this total, 211 nmi (11 transects) were sampled in Spanish waters, and 111 nmi (10 transects) in the Portuguese waters. The enclosed text table below provides the nautical area-scattering coefficients attributed to each of the selected target species and for the whole "pelagic fish assemblage".

S_A (m^2 nmi^{-2})	Total spp.	PIL	SAA	ANE	MAC	VMA	HOM	HMM	JAA	BOG	BOC	SNS	MAV
Total Area	184301	43118	2028	64869	6	44927	5415	16096	1143	1849	124	227	4499
(%)	(100.0)	(23.4)	(1.1)	(35.2)	(0.003)	(24.4)	(2.9)	(8.7)	(0.6)	(1.0)	(0.1)	(0.1)	(2.4)
Portugal	61499	12983	0	7245	1	32915	5090	0	1141	1312	124	227	461
(%)	(33.4)	(30.1)	(0.0)	(11.2)	(22,2)	(73,3)	(94.4)	(0.0)	(99.8)	(70.9)	(100.0)	(100.0)	(10.2)
Spain	122802	30135	2028	57623	5	12012	325	16096	2	537	0	0	4038
(%)	(66.6)	(69.9)	(100.0)	(88.8)	(77.8)	(26.7)	(6.0)	(100.0)	(0.2)	(29.1)	(0.0)	(0.0)	(89.8)

For this "pelagic fish assemblage" has been estimated a total of 184 301 m^2 nmi^{-2}, an acoustic energy which has experienced a slight decrease in relation to the time-series maxima recorded in 2018 and 2019 both for this total and for the Spanish contribution. Even so, these values are above the historical average (**Figure 17**). Portuguese waters accounted for 33% of this total back-scattering energy and the Spanish waters the remaining 67%. However, given that the Portuguese sampled ESDUs were almost the half of the Spanish ones, the (weighted-) relative importance of the Portuguese area (*i.e.*, its density of "pelagic fish") is actually much higher. The mapping of the total back-scattering energy is shown in **Figure 17**. By species, anchovy (35%), chub mackerel (24%) and sardine (23%), were the most important species in terms of their contributions to the total back-scattering energy. Mediterranean horse mackerel (9%), horse mackerel (3%), pearlside (2%) and round sardinella and bogue (1% each), were the following species in importance. The remaining species contributed with less than 1%.

Some inferences on the species' distribution may be carried out from regional contributions to the total energy attributed to each species: sardine, round sardinella, anchovy, mackerel, Mediterranean horse mackerel, and pearlside seemed to show greater densities in the Spanish waters, whereas chub mackerel,

blue jack mackerel, horse mackerel, bogue, boarfish and snipefish could be considered as typically "Portuguese species" in this survey.

According to the resulting values of integrated acoustic energy, the species acoustically assessed in the present survey finally were anchovy, sardine, mackerel, chub mackerel, blue jack mackerel, horse mackerel, Mediterranean horse mackerel, bogue, boarfish, longspine snipefish and pearlside.

Spatial distribution and abundance/biomass estimates

Anchovy

Parameters of the survey's length-weight relationship for anchovy are given in **Table 4**. The back-scattering energy attributed to this species and the coherent strata considered for the acoustic estimation are shown in **Figure 18**. The estimated abundance and biomass by size class are given in **Table 5**, and **Figure 19**.

Anchovy (35% of the total NASC attributed to fish) was widely distributed in the surveyed area, showing the highest densities between Cape Santa Maria and Bay of Cadiz (**Figure 20**). The PELAGO spring survey not recorded the species to the west of Cape Santa Maria.

Twelve (12) coherent post-strata have been differentiated according to the S_A value distribution and the size composition in the fishing stations (**Figure 18**). The acoustic estimates by homogeneous post-stratum and total area are shown in **Table 5** and **Figure 19**. Overall acoustic estimates in summer 2020 were 5153 million fish and 44 877 tonnes. By geographical strata, the Spanish waters yielded 91% (4714 million) and 83% (37 114 t) of the total estimated abundance and biomass in the Gulf, confirming the importance of these waters in the species' distribution. The estimates for the Portuguese waters were 439 million and 7773 t. The current biomass estimate (44 877 t) becomes in the second historical maximum within the time-series (historical maximum in 2019: 57 700 t; **Figure 33**). The PELAGO 20 spring Portuguese survey previously estimated for this same area 49 787 t and 5639 million (Portuguese waters: 1789 t, 89 million; Spanish waters: 47 998 t, 5550 million).

The size class range of the assessed anchovy population in summer 2020 varied between the 7.0 and 18.0 cm size classes, with two modal classes, the main mode at 11.5 cm and a secondary mode at 9.5 cm. The size composition of anchovy throughout the surveyed area confirms the usual pattern exhibited by the species during the survey season, with the largest (and oldest) fish being distributed in the westernmost waters and the smallest (and youngest) ones concentrated in the surroundings of the Guadalquivir river mouth and adjacent shallow waters (**Table 5, Figure 19;** see also **Figure 5**). The 2020 summer estimates of mean size and weight of the whole population (11.0 cm, 8.7 g) were somewhat lower than their respective time-series averages (12.3 cm, 12.6 g). As has been occurring in the last years, a relatively high contribution of the small fish (ca. 40 % of the total population is composed by fish ≤10 cm) during the survey season might be the cause of the value of such estimates in 2020.

Sardine

Parameters of the survey's size-weight relationship for sardine are shown in **Table 4**. The back-scattering energy attributed to this species and the coherent strata considered for the acoustic estimation are shown in **Figure 20**. Estimated abundance and biomass by size class are given in **Table 6** and **Figure 21**.

Sardine recorded a relatively high acoustic echo-integration in summer 2019 (23% of the total NASC attributed to pelagic fish species assemblage), as a consequence of the occurrence of dense mid-water schools in the coastal fringe (20-40 m depth) of the Spanish central waters of the Gulf (**Figure 20**). This distribution pattern of acoustic densities was quite similar to the recorded one during the PELAGO survey in

spring, although acoustic detections were weaker during ECOCADIZ. Thus, sardine distributed almost all over the surveyed area (avoiding the Spanish easternmost waters), but was mainly concentrated between west Cape Santa Maria and the Bay of Cadiz.

Eight (8) size-based homogeneous sectors were delimited for the acoustic assessment (**Figure 20**). The estimates of Gulf of Cadiz sardine abundance and biomass in summer 2020 were 1923 million fish and 50 721 t, estimates close to the historical average (ca. 1955 million; 50 kt), but lower than the values estimated last year and the most recent maxima reached in 2018 (114 631 t; see **Figure 33**). Spanish waters concentrated 71% and 62% of the total estimated abundance and biomass, respectively (2495 million and 44 899 t). The estimates for the Portuguese waters were 554 million and 19 464 t. The PELAGO 20 spring Portuguese survey previously estimated for this same area the triple of biomass and abundance than the estimated later in summer by ECOCADIZ, 155 017 t (6547 million): 47 415 t (1024 million) in Portuguese waters and 107 602 t (5523 million) in Spanish waters, with similar regional relative contributions.

Sizes of the assessed population ranged between 10.5 and 20.0 cm size classes. The length frequency distribution of the population was clearly bimodal, with one main mode at 11.5 cm size class and a secondary one at 15.0 cm (**Table 6**, **Figure 24**). The relatively important juvenile fraction in the estimated population (≤11.5 cm), was mainly located in relatively shallow waters along the coastal fringe comprised between Matalascañas and the Bay of Cadiz (**Table 6**, **Figure 24**; see also **Figure 7**).

Sizes of the assessed sardine population in summer 2020 ranged between 8.5 and 21.5 cm size classes. The length frequency distribution of the population was clearly bimodal, with one main mode at 14.0 cm size class and a secondary one at 17.0 cm (**Table 6**, **Figure 21**). The juvenile fraction in the estimated population (≤11.5 cm), was mainly located in relatively shallow waters along the coastal fringe comprised between Tinto-Odiel river mouth and the Bay of Cadiz. (**Table 6**, **Figure 21;** see also **Figure 6**). The 2020 summer estimates of mean length and weight of the whole population (14.7 cm, 26.4 g) have experienced an increase in relation to the last year's estimates. Mean length in summer 2020 is close to the historical average (15.0 cm) and mean weight is higher than the historical mean value (22.5 g), a probable consequence of the relative importance of the abovementioned secondary modal component in the estimated population biomass.

Round sardinella

Parameters of the survey's length-weight relationship are shown in **Table 4**. The distribution of the back-scattering energy attributed to this species is shown in **Figure 22**.

Round sardinella (1% of the total NASC) showed very low densities, mainly restricted to the easternmost coastal waters in the Gulf (**Figure 22**; see also **Figure 7**).

Mackerel

Parameters of the survey's length-weight relationship are shown in **Table 4**. The distribution of the back-scattering energy attributed to this species is shown in **Figure 23**.

Atlantic mackerel (0.003% of the total NASC) showed a relatively wide distribution all over the surveyed area, but showing somewhat higher densities in Spanish waters (**Figure 23**). Sub-adult/juvenile fish were mainly recorded in outer shelf of west Algarve and the Spanish central and easternmost waters, whereas larger fish occurred in shallower waters (**Figure 8**).

Chub mackerel

Parameters of the survey's length-weight relationship are shown in **Table 4**. The distribution of the back-scattering energy attributed to this species and the coherent strata considered for the acoustic estimation are shown in **Figure 24**. Estimated abundance and biomass by size class are given in **Table 7** and **Figure 25**.

Chub mackerel was widely distributed in the surveyed area, mainly in the central and western shelf waters, although the highest densities occurred in the western Algarve (**Figure 24**).

Sixteen (16) size-based homogeneous sectors were delimited for the acoustic assessment (**Figure 24**). The estimates of Gulf of Cadiz chub mackerel abundance and biomass in summer 2020 were 448 million fish and 32 854 t. These estimates and the most recent ones showed a relative stable recent trend, with biomasses very close to the historical average (ca. 35 kt; see **Figure 33**). Portuguese waters concentrated the bulk of the population (356 million and 24 495 t). The estimates for the Spanish waters were 92 million and 8358 t.

Sizes of the assessed population ranged between 15.0 and 35.5 cm size classes. The length frequency distribution of the population showed two modes, the main mode at 19.0 cm size class and a secondary one at 21.0 cm (**Table 7**; **Figure 25**). Larger fish were located in Portuguese waters, although the largest ones were recorded in the coastal waters in front Matalascañas. Smaller sub-adult fish were found in the Spanish outer shelf waters (**Figures 9** and **25**).

Blue jack-mackerel

The survey's length-weight relationship for this species is given in **Table 4**. The distribution of the back-scattering energy attributed to this species is illustrated in **Figure 26**.

The species (0.6% of the total NASC) restricted almost exclusively to Algarve shelf waters, with spots of higher densities in the westernmost waters (**Figure 26**). The species' distribution resembles the horse mackerel distribution. Larger fish occurred in Portuguese waters (**Figure 10**).

Horse mackerel

The survey's length-weight relationship for horse mackerel is shown in **Table 4**. The back-scattering energy attributed to this species is shown in **Figure 27**.

Horse mackerel (3% of the total NASC) showed a quite similar distribution pattern to the abovementioned one for blue jack mackerel, with the species being almost absent in the Spanish shelf and showing relatively higher densities in the shelf area comprised between Cape San Vicente and Cape Santa Maria (**Figure 27**). Juveniles occurred in the Spanish outer shelf central waters (**Figure 11**).

Mediterranean horse-mackerel

The survey's length-weight relationship for this species is shown in **Table 4**. Back-scattering energy attributed to the species is represented in **Figure 28**.

Mediterranean horse mackerel (9% of the total NASC was a typically Spanish species in summer 2020 (as usual). The species distributed as far as the Tinto-Odiel river mouth, mainly over the inner-mid shelf waters with the population mainly being composed by adult fish (**Figures 12** and **28**).

Bogue

Parameters of the survey's length-weight relationship for bogue are shown in **Table 4**. Back-scattering energy attributed to bogue is shown in **Figure 29**.

Bogue (1% of the total NASC), although widely distributed, showed higher densities in the west Algarve waters (**Figure 29**). Larger fish occurred in Spanish waters (**Figure 13**).

Longspine snipefish

The survey's length-weight relationship for this species is shown in **Table 4**. Back-scattering energy attributed to the species is represented in **Figure 30**.

M. scolopax (0.1% of the total NASC) showed an incidental occurrence in the surveyed area, mainly restricted to the westernmost Algarve outer shelf waters, like boarfish, and also close to the Cape Santa Maria (**Figures 14** and **30**).

Boarfish

Parameters of the survey's length-weight relationship for boarfish are shown in **Table 4**. Back-scattering energy attributed to the species is shown in **Figure 31**.

Boarfish (0.1% of the total NASC) showed an incidental occurrence in the westernmost Algarve outer shelf waters (**Figures 15** and **32**).

Pearlside

The survey's length-weight relationship for this species is shown in **Table 4**. Back-scattering energy attributed to the species is represented in **Figure 32**.

Pearlside (2% of the total NASC) was only detected in the oceanic limit of the acoustic transects, just in the upper slope. More common in Spanish waters (**Figures 16 and 32**).

(SHORT) DISCUSSION

The total NASC estimated in this survey for "pelagic fish assemblage", 184 301 m^2 nmi^{-2}, is the third highest estimate ever recorded within the time-series (**Figure 19**), a situation which was repeated in the last two years' surveys. In the current survey such an increase in acoustic energy is again the result of the relatively high partial contributions of anchovy, sardine, chub mackerel (as was also the case of the last two years). Anchovy contributed with 35% of the total NASC allocated to the pelagic fish assemblage, with the Spanish waters accounting 89% of the species' NASC. Sardine still showed during the 2020 summer survey the occurrence of dense schools in the coastal (20-40 m) waters in the central part of the Gulf (between the Guadiana river mouth and Doñana).

The current anchovy biomass estimate (44 877 t), although experienced a slight decrease in relation to the last year, becomes in the second historical maximum within the time-series (after reaching the historical maximum in 2019: 57 700 t; see **Figure 33**). The spring *PELAGO 20* survey estimated, however, increased biomass population levels (49 787 t) in relation to those recorded the last year (29 876 t).

The estimates of Gulf of Cadiz sardine abundance and biomass in summer 2020 were 1923 million fish and 50 721 t, a biomass very close to the historical average (ca. 50 kt), but lower than the biomass estimated the previous two years (114 631 t in 2018 and 62 682 t in 2019, **Figure 33**). The *PELAGO 20* spring

Portuguese survey previously estimated for this same area the triple of biomass and abundance than the estimated later in summer by ECOCADIZ, 155 017 t (6547 million). Again PELAGO and ECOCADIZ exhibit an opposite trend for this last year in the series.

Chub mackerel acoustic estimates were of 448 million fish and 32 854 t, with the bulk of the population concentrated in the Portuguese waters. The biomass estimates showed a relative stable recent trend, with the recent biomasses very close to the historical average (ca. 35 kt; **Figure 36**).

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Table 1. *ECOCADIZ 2020-07 s*urvey. Descriptive characteristics of the acoustic tracks.

Acoustic Track	Location	Date	Start				End			
			Latitude	Longitude	UTC time	Mean depth (m)	Latitude	Longitude	UTC time	Mean depth (m)
R01	Cape Trafalgar	02/08/20	36º 12,880’ N	06º 08,840’ W	6:06	24	36º 02,160’ N	06º 28,870’ W	9:48	220
R02	Sancti-Petri	02/08/20	36º 08,898’ N	06º 34,152’ W	10:44	175	36º 19,490’ N	06º 14,670’ W	16:40	24
R03	Cádiz	03/08/20	36º 26,702’ N	06º 19,114’ W	6:01	31	36º 17,111’ N	06º 36,809’ W	9:29	219
R04	Rota	03/08/20	36º 24,560’ N	06º 40,681’ W	10:23	181	36º 34,879’ N	06º 21,880’ W	14:04	21
R05	Chipiona	04/08/20	36º 40,394’ N	06º 29,386’ W	6:00	22	36º 31,176’ N	06º 46,423’ W	9:44	182
R06	Doñana	04/08/20	36º 08,078’ N	06º 51,475’W	10:57	167	36º 46,708’N	06º 35,591’ W	16:09	23
R07	Matalascañas	05/08/20	36º 54,385’ N	06º 39,191’ W	6:08	20	36º 43,948’ N	06º 58,417’ W	8:03	213
R08	Mazagón	06/08/20	37º 00,862’ N	06º 44,971’ W	7:35	23	36º 48,940’ N	07º 05,670’ W	11:35	268
R09	Punta Umbría	06/08/20	36º 49,737’ N	07º 06,547’ W	13:44	157	37º 03,920’ N	06º 56,385’ W	17:41	30
R10	El Rompido	07/08/20	37º 07,962’ N	07º 07,192’ W	6:32	20	36º 49,985’ N	07º 07,201’ W	9:56	218
R11	Isla Cristina	08/08/20	37º 06,847’ N	07º 17,346’ W	7:31	24	36º 53,310’ N	07º 17,160’ W	10:34	253
R12	V.R. do Sto. Antonio	08/08/20	36º 56,324’ N	07,27,127’ W	12:21	199	369º 06,420’ N	07º 27,168’ W	13:21	20
R13	Tavira	09/08/20	37º 04,465’ N	07º 37,127’ W	6:09	25	36º 56,929’ N	07º 37,095’ W	8:50	272
R14	Fuzeta	09/08/20	36º 55,551’ N	07º 47,076’ W	9:43	192	36º 59,385’ N	07º 47,079’ W	10:06	29
R15	Cape Sta. María	10/08/20	36º 55,746’ N	07º 57,021‘ W	6:30	63	36º 52,070’ N	07º 57,969‘ W	6:53	214
R16	Quarteira	10/08/20	36º 49,745’ N	08º 06,883’ W	9:36	200	37º 00,125’ N	08º 07,056’ W	10:41	35
R17	Albufeira	11/08/20	37º 02,270’ N	08º 17,041’ W	6:34	22	36º 49,448’ N	08º 16,880’ W	9:38	199
R18	Alfanzina	11/08/20	36º 50,239’ N	08º 26,758’ W	10:32	206	37º 04,522’ N	08º 27,027’ W	14:02	22
R19	Portimao	12/08/20	37º 05,982’ N	08º 37,059‘ W	6:29	25	36º 51,512’ N	08º 36,750’ W	7:55	193
R20	Burgau	12/08/20	36º 51,947’ N	08º 46,677’ W	10:07	197	37º 02,731’ N	08º 46,931’ W	13:39	44
R21	Ponta de Sagres	12/08/20	36º 58,882’ N	08º 56,783’ W	14:51	31	36º 50,531’ N	08º 56,601’ W	16:30	216

Table 2. *ECOCADIZ 2020-07* survey. Descriptive characteristics of the fishing hauls. PE01-PE28 carried out with the *Tuneado* gear, PE29-PE30 with the Gloria HOD 352 gear. Hauls shaded in grey were conducted by night to collect anchovy hydrated females (DEPM).

FISHING STATION	DATE	POSITION						TIMING				TRAWLED DISTANCE (nmi)	ACOUSTIC TRANSECT	ZONE/LANDMARK
		START			END			START	END	EFFECTIVE TRAWLING	TOTAL MANEOUVRE			
		LAT.	LON.	DEP.	LAT.	LON.	DEP.	UTC	UTC					
PE01	02-08-2020	36º 03.8961 N	6º 25.4461 W	102,2	36º 05.9067 N	6º 22.1191 W	55,44	08:03	08:51	00:48	01:10	3,362	R01	Cape Trafalgar
PE02	02-08-2020	36º 11.8475 N	6º 28.3901 W	103,57	36º 09.8838 N	6º 32.3501 W	130	11:40	12:34	00:54	01:16	3,758	R02	Sancti-Petri
PE03	02-08-2020	36º 17.0228 N	6º 18.8575 W	43,76	36º 14.8750 N	6º 22.8320 W	52,92	14:37	15:31	00:54	01:13	3,864	R02	Sancti-Petri
PE04	03-08-2020	36º 22.8547 N	6º 26.3554 W	58,23	36º 24.5949 N	6º 22.9591 W	46,77	06:58	07:43	00:45	01:08	3,246	R03	Cádiz
PE05	03-08-2020	36º 29.5434 N	6º 31.7356 W	65,79	36º 27.5109 N	6º 35.2552 W	92,08	11:39	12:27	00:48	01:09	3,49	R04	Rota
PE06	04-08-2020	36º 35.5284 N	6º 38.3322 W	70,26	36º 37.9722 N	6º 33.9490 W	39,63	07:09	08:09	00:59	01:21	4,291	R05	Chipiona
PE07	04-08-2020	36º 41.0306 N	6º 46.3194 W	95,57	36º 39.3219 N	6º 50.3730 W	127,37	11:42	12:30	00:48	01:10	3,681	R06	Doñana
PE08	04-08-2020	36º 43.0302 N	6º 42.3165 W	53,87	36º 41.2464 N	6º 45.7079 W	88,11	14:08	14:52	00:44	01:07	3,257	R06	Doñana
PE09	05-08-2020	36º 44.4801 N	6º 57.2988 W	137,9	36º 46.2178 N	6º 54.3289 W	104,29	08:33	09:15	00:41	01:13	2,951	R07	Matalascañas
PE10	05-08-2020	36º 44.6802 N	6º 56.8048 W	130,82	36º 45.8449 N	6º 55.0405 W	112,1	18:22	18:48	00:26	00:54	1,834	R07	Matalascañas
PE11	05-08-2020	36º 45.8382 N	6º 54.8398 W	111,07	36º 44.6895 N	6º 57.0451 W	131,56	19:37	20:07	00:30	00:52	2,111	R07	Matalascañas
PE12	06-08-2020	36º 57.2017 N	6º 48.5350 W	35,59	36º 58.9782 N	6º 50.9701 W	35,93	08:35	09:13	00:38	00:-01	2,637	R08	Mazagón
PE13	06-08-2020	36º 50.5042 N	7º 04.0333 W	128,16	36º 52.5112 N	7º 00.5593 W	102,5	11:59	12:46	00:47	01:11	3,434	R08	Mazagón
PE14	06-08-2020	36º 57.1975 N	7º 01.1755 W	73,22	36º 54.7629 N	7º 02.6937 W	97,87	15:39	16:18	00:38	01:03	2,719	R09	Punta Umbría
PE15	07-08-2020	36º 56.4820 N	7º 07.1253 W	95,56	36º 59.3737 N	7º 07.2618 W	67,68	08:01	08:41	00:39	01:02	2,89	R10	El Rompido
PE16	07-08-2020	36º 50.3188 N	7º 07.2193 W	190,84	36º 53.1177 N	7º 07.2580 W	117,93	11:14	11:53	00:39	01:10	2,795	R10	El Rompido
PE17	07-08-2020	36º 56.9920 N	7º 01.2897 W	73,74	36º 55.2672 N	7º 02.3785 W	91,77	19:45	20:10	00:25	00:46	1,931	R09	Punta Umbría
PE18	07-08-2020	36º 55.1620 N	7º 02.3589 W	91,65	36º 57.1665 N	7º 01.1956 W	70,77	20:49	21:19	00:30	00:48	2,208	R09	Punta Umbría
PE19	08-08-2020	36º 57.0655 N	7º 17.1874 W	104,7	36º 59.9715 N	7º 17.2321 W	82,65	08:55	09:35	00:40	01:05	2,902	R11	Isla Cristina
PE20	08-08-2020	37º 01.7614 N	7º 25.4350 W	89,05	37º 02.3014 N	7º 28.6177 W	87,27	14:29	15:04	00:35	01:10	2,605	R12	Vila Real do Santo Antonio
PE21	09-08-2020	37º 02.5972 N	7º 36.0627 W	62	37º 02.1297 N	7º 37.6191 W	64,93	07:45	08:04	00:18	00:39	1,331	R13	Tavira
PE22	09-08-2020	36º 56.6653 N	7º 47.3578 W	90,68	36º 58.1019 N	7º 44.2978 W	95,66	11:20	11:58	00:37	01:02	2,841	R14	Fuzeta
PE23	09-08-2020	36º 57.4293 N	7º 37.0581 W	163,71	36º 59.1574 N	7º 37.0833 W	102,49	13:17	13:40	00:23	00:51	1,726	R13	Tavira
PE24	10-08-2020	36º 53.6404 N	7º 58.3531 W	92,56	36º 53.9695 N	7º 56.1154 W	91,41	07:50	08:15	00:25	00:47	1,825	R15	Cape Santa María
PE25	10-08-2020	36º 58.8162 N	8º 07.1766 W	41,47	36º 55.7527 N	8º 06.9198 W	51,76	11:18	12:00	00:41	01:05	3,066	R16	Cuarteira
PE26	11-08-2020	36º 52.5466 N	8º 16.9699 W	108,93	36º 56.0752 N	8º 17.0067 W	80,39	07:51	08:40	00:49	01:12	3,524	R17	Albufeira
PE27	11-08-2020	36º 50.8603 N	8º 24.8509 W	137,47	36º 50.9034 N	8º 22.8960 W	126,03	11:45	12:06	00:21	00:53	1,57	R18	Alfanzina
PE28	11-08-2020	36º 59.1541 N	8º 24.5935 W	45,45	36º 59.2177 N	8º 24.9019 W	45,87	15:17	15:22	00:04	00:24	0,255	R18	Alfanzina
PE29	12-08-2020	36º 52.8229 N	8º 36.7441 W	115,12	36º 55.3597 N	8º 36.7837 W	98,13	08:15	08:52	00:36	01:03	2,534	R19	Portimao
PE30	12-08-2020	36º 56.0071 N	8º 46.8201 W	114,55	36º 52.8661 N	8º 46.5577 W	112,34	11:33	12:15	00:42	01:10	3,144	R20	Burgau

Table 3. *ECOCADIZ 2020-07* survey. Catches by species in number (upper panel) and weight (in kg, lower panel) from valid fishing hauls.

Fishing haul	CATCH IN NUMBERS													
	ANE	PIL	SAA	MAS	MAC	HOM	JAA	HMM	BOG	BOC	SNS	MAV	OTHERS SPP	TOTAL
01	13946	0	0	667	67	1228	2	0	1	0	0	0	120	**16031**
02	275	0	0	16807	21	1	0	10	0	0	0	0	0	**17114**
03	0	0	356	77	0	0	0	964	3	0	0	0	291	**1691**
04	1613	35778	3	1762	3	8	0	1354	172	0	0	0	341	**41034**
05	25245	36359	0	548	53	1	0	0	18	0	0	0	108	**62332**
06	114750	421	0	9	8	9	0	56	34	0	0	0	119	**115406**
07	49868	0	0	120	20	0	0	0	0	0	0	0	50	**50058**
08	103187	8118	0	141	24	24	0	0	3	0	0	0	80	**111577**
09	77913	0	0	1283	45	1	2	0	0	0	0	0	66	**79310**
12	95	3	20	814	0	1	0	626	70	0	0	0	175	**1804**
13	79653	0	0	107	5	0	1	5	1	0	0	0	37	**79809**
14	60536	29482	0	5391	41	2	0	0	0	0	0	0	19	**95471**
15	25047	40324	0	883	6	1	0	0	3	0	0	0	36	**66300**
16	79633	10	0	149	18	10	1	0	0	0	0	67	45	**79933**
19	6004	0	0	1008	18	9	0	0	0	0	0	0	33	**7072**
20	92664	1898	0	43	13	1	0	0	0	0	0	0	24	**94643**
21	65155	7183	0	1009	8	0	0	0	0	0	0	0	8	**73363**
22	1	9	0	6275	6	192	18	0		0	0	0	7	**6508**
23	0	0	0	127	2	58	14	0	1	0	112	0	2	**316**
24	1692	13104	0	481	9	497	28	0	52	0	0	0	69	**15932**
25	0	38467	0	46800	7	297	8	0	681	0	0	0	1430	**87690**
26	1509	32	0	7590	6	142	2	0	68	0	0	0	179	**9528**
27	0	0	0	20	7	0	14	0	0	0	0	0	6	**47**
28	0	37	0	66	0	1382	442	0	188	0	0	0	799	**2914**
29	6694	0	0	13	1	0	0	0	1	784	28	0	21	**7542**
30	170	0	0	316	2	13	2	0	1	0	996	0	19	**1519**
TOTAL	**805650**	**211225**	**379**	**92506**	**390**	**3877**	**534**	**3015**	**1297**	**784**	**1136**	**67**	**4084**	**1124944**

Table 3. *ECOCADIZ 2020-07* survey. Cont'd.

Fishing haul	CATCH IN WEIGHT (kg)													
	ANE	PIL	SAA	MAS	MAC	HOM	JAA	HMM	BOG	BOC	SNS	MAV	OTHERS SPP	TOTAL
01	212,345	0	0	35,035	3,260	89,525	0,034	0	0,044	0	0	0	26,759	**367,002**
02	7,410	0	0	891,425	0,740	0,098	0	4,050	0	0	0	0	0	**903,723**
03	0	0	65,475	8,235	0	0	0	192,420	0,495	0	0	0	41,845	**308,470**
04	17,461	582,176	0,284	187,766	1,060	0,654	0	250,149	29,550	0	0	0	48,911	**1118,011**
05	233,085	489,821	0	38,830	11,000	0,085	0	0	4,395	0	0	0	17,955	**795,171**
06	582,878	4,796	0	0,795	1,480	0,170	0	11,160	8,940	0	0	0	15,645	**625,864**
07	370,215	0	0	7,433	3,152	0	0	0	0	0	0	0	8,235	**389,035**
08	492,806	98,233	0	11,155	4,045	0,376	0	0	0,635	0	0	0	18,595	**625,845**
09	844,715	0	0	78,400	6,115	0,210	0,09	0	0	0	0	0	8,890	**938,420**
12	0,990	0,032	5,115	194,235	0	0,025	0	124,060	16,480	0	0	0	25,050	**365,987**
13	903,590	0	0	5,485	0,520	0	0,03	1,000	0,260	0	0	0	9,330	**920,215**
14	569,937	599,568	0	432,275	7,605	0,050	0	0	0	0	0	0	7,090	**1616,525**
15	232,626	1080,325	0	50,800	1,180	0,030	0	0	0,545	0	0	0	5,160	**1370,666**
16	1125,821	0,320	0	10,455	1,855	1,980	0,04	0	0	0	0	0,081	5,760	**1146,312**
19	82,902	0	0	86,050	2,635	0,560	0	0	0	0	0	0	3,290	**175,437**
20	1245,826	46,027	0	2,375	1,185	0,190	0	0	0	0	0	0	2,050	**1297,653**
21	984,406	237,874	0	72,990	1,280	0	0	0	0	0	0	0	1,015	**1297,565**
22	0,024	0,545	0	599,080	1,620	14,110	1,05	0	2,130	0	0	0	1,110	**619,669**
23	0	0	0	14,150	0,415	9,770	1,815	0	0,170	0	1,3	0	0,225	**27,845**
24	40,180	555,210	0	32,305	1,020	40,440	1,54	0	7,310	0	0	0	9,905	**687,910**
25	0	1125,129	0	2828,557	3,210	20,885	0,546	0	76,190	0	0	0	197,010	**4251,527**
26	33,660	1,840	0	498,010	0,410	15,090	0,11	0	7,370	0	0	0	18,270	**574,760**
27	0	0	0	1,402	0,347	0	1,224	0	0	0	0	0	0,320	**3,293**
28	0	1,935	0	5,995	0	104,505	28,48	0	18,050	0	0	0	146,750	**305,715**
29	164,030	0	0	1,025	0,050	0	0	0	0,090	3,83	0,165	0	1,580	**170,770**
30	5,375	0	0	29,790	0,090	1,325	0,14	0	0,110	0	6,785	0	1,9950	**45,610**
TOTAL	**8150,282**	**4823,831**	**70,874**	**6124,053**	**54,274**	**300,078**	**35,099**	**582,839**	**172,764**	**3,83**	**8,25**	**0,081**	**622,745**	**20949**

Table 4. *ECOCADIZ 2020-07* survey. Parameters of the size-weight relationships for survey's target species. FAO codes for the species: ANE: *Engraulis encrasicolus*; PIL: *Sardina pilchardus*; SAA: *Sardinella aurita*; VAM: *Scomber colias*; MAC: *Scomber scombrus*; HOM: *Trachurus trachurus*; JAA: *Trachurus picturatus;* HMM: *Trachurus mediterraneus*; BOG: *Boops boops*; BOC: *Capros aper*; SNS: *Macrorhamphosus scolopax*; MAV: *Maurolicus muelleri* (*: parameters from the ECOCADIZ 2019-07 survey).

PARAMETER	ANE	PIL	SAA	VAM	MAC	HOM	JAA	HMM	BOG
Size range (mm)	72 - 186	108 - 216	223 - 349	163 - 388	164 - 403	78 - 337	145 - 281	168 - 412	164 - 331
n	1509	639	345	1199	387	416	133	203	367
a	0.002151	0.004150	0.026995	0.003621	0.001368	0.009470	0.004957	0.018000	0.008441
b	3.414748	3.238180	2.621522	3.243804	3.512345	2.940128	3.150865	2.733727	3.022297
r^2	0.98	0.98	0.89	0.98	0.99	0.99	0.96	0.96	0.97

PARAMETER	BOC	SNS	MAV(*)
Size range (mm)	47 - 93	83 - 145	36 - 64
n	170	284	98
a	0.026171	0.003501	0,010578
b	2.849139	3.134380	2,869503
r^2	0.90	0.89	0,96

Table 5. *ECOCADIZ 2020-07* survey. Anchovy (*E. encrasicolus*). Estimated abundance (absolute numbers and million fish) and biomass (t) by size class (in cm). Polygons (*i.e.*, coherent or homogeneous post-strata) numbered as in **Figure 18**.

ECOCADIZ 2020-07 . Engraulis encrasicolus . ABUNDANCE (in numbers and million fish)																			
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	**POL06**	**POL07**	**POL08**	**POL09**	**POL10**	**POL11**	**POL12**	**POL13**	***n***			**Millions**		
														PORTUGAL	**SPAIN**	**TOTAL**	**PORTUGAL**	**SPAIN**	**TOTAL**
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	25826006	0	0	0	0	0	0	25826006	25826006	0	26	26
7,5	0	0	0	0	0	0	0	189088838	0	0	0	0	0	0	189088838	189088838	0	189	189
8	0	0	0	0	0	0	0	260328587	0	0	0	0	0	0	260328587	260328587	0	260	260
8,5	0	0	0	0	0	0	0	269849042	0	406033	0	0	0	0	270255075	270255075	0	270	270
9	0	250390	0	0	0	5799098	0	386101751	3635224	93714	0	0	0	250390	395629787	395880177	0	396	396
9,5	0	0	0	0	0	13353196	0	508716153	24720234	343495	0	0	0	0	547133078	547133078	0	547	547
10	0	0	0	0	0	31222831	0	279916324	39991011	62538	0	0	0	0	351192704	351192704	0	351	351
10,5	0	0	1492128	73025	2933	156660616	425654	184445807	35629450	93714	2028898	326100	0	1492128	379686197	381178325	1	380	381
11	0	0	5133118	251215	10089	371854836	1464308	158362785	34173235	1405342	6122290	975561	123	5133118	574619784	579752902	5	575	580
11,5	0	0	22240760	1088465	43712	503306766	6344548	45949260	19632337	1124385	15270129	1463341	492	22240760	594223435	616464195	22	594	616
12	0	0	55806852	2731192	109683	420770331	15919836	20658771	13088225	812066	18687221	3578882	369	55806852	496356576	552163428	56	496	552
12,5	0	1604645	46011327	2251798	90431	231154492	13125500	0	5091440	218605	8151188	6831664	492	47615972	266915610	314531582	48	267	315
13	0	4824009	58301953	2853302	114586	143429181	16631606	5167236	726336	31176	4413744	8618365	861	63125962	181986393	245112355	63	182	245
13,5	106717	7452805	45063177	2205395	88567	64706857	12855024	0	0	93714	1708546	5691683	1231	52622699	87351017	139973716	53	87	140
14	533585	15557635	36583615	1790405	71901	38733859	10436087	0	0	0	1032247	3414462	861	52674835	55479822	108154657	53	55	108
14,5	533585	27485074	13311048	651444	26161	19253664	3797199	0	0	0	0	1625021	615	41329707	25354104	66683811	41	25	67
15	1600755	30021103	8349283	408615	16410	2982649	2381772	0	0	0	0	161680	861	39971141	5951987	45923128	40	6	46
15,5	3308227	19938807	2240312	109641	4403	0	639086	0	0	0	0	975561	4061	25487346	1732752	27220098	25	2	27
16	4482114	10403140	389797	19077	766	0	111196	0	0	0	0	1301661	11814	15275051	1444514	16719565	15	1	17
16,5	4695548	4952300	0	0	0	0	0	0	0	0	0	1951121	7384	9647848	1958505	11606353	10	2	12
17	1600755	2852104	0	0	0	0	0	0	0	0	0	1301661	3938	4452859	1305599	5758458	4	1	6
17,5	960453	603955	0	0	0	0	0	0	0	0	0	0	615	1564408	615	1565023	2	0,001	2
18	320151	0	0	0	0	0	0	0	0	0	0	0	123	320151	123	320274	0,3	0,0001	0,3
18,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL *n*	18141890	125945967	294923370	14433574	579642	2003228376	84131816	2334410560	176687492	4684782	57414263	38216763	33840	439011227	4713821108	5152832335	**439**	**4714**	**5153**
Millions	**18**	**126**	**295**	**14**	**1**	**2003**	**84**	**2334**	**177**	**5**	**57**	**38**	**0,03**						

Table 5. *ECOCADIZ 2020-07* survey. Anchovy (*E. encrasicolus*). Cont'd.

ECOCADIZ 2020-07 . Engraulis encrasicolus . BIOMASS (t)																
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	**POL06**	**POL07**	**POL08**	**POL09**	**POL10**	**POL11**	**POL12**	**POL13**	**PORTUGAL**	**SPAIN**	**TOTAL**
6	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
6,5	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
7	0	0	0	0	0	0	0	48,152	0	0	0	0	0	**0**	**48,152**	**48,152**
7,5	0	0	0	0	0	0	0	442,719	0	0	0	0	0	**0**	**442,719**	**442,719**
8	0	0	0	0	0	0	0	754,575	0	0	0	0	0	**0**	**754,575**	**754,575**
8,5	0	0	0	0	0	0	0	956,230	0	1,439	0	0	0	**0**	**957,669**	**957,669**
9	0	1,073	0	0	0	24,843	0	1654,069	15,573	0,401	0	0	0	**1,073**	**1694,886**	**1695,959**
9,5	0	0	0	0	0	68,471	0	2608,545	126,758	1,761	0	0	0	**0**	**2805,535**	**2805,535**
10	0	0	0	0	0	189,916	0	1702,616	243,249	0,380	0	0	0	**0**	**2136,161**	**2136,161**
10,5	0	0	10,679	0,523	0,021	1121,195	3,046	1320,049	254,994	0,671	14,52	2,334	0	**10,679**	**2717,353**	**2728,032**
11	0	0	42,907	2,100	0,084	3108,248	12,240	1323,718	285,646	11,747	51,175	8,154	0,001	**42,907**	**4803,113**	**4846,020**
11,5	0	0	215,665	10,555	0,424	4880,493	61,522	445,563	190,372	10,903	148,072	14,190	0,005	**215,665**	**5762,099**	**5977,764**
12	0	0	623,906	30,534	1,226	4704,104	177,980	230,960	146,323	9,079	208,918	40,011	0,004	**623,906**	**5549,139**	**6173,045**
12,5	0	20,565	589,691	28,860	1,159	2962,527	168,219	0	65,253	2,802	104,467	87,556	0,006	**610,256**	**3420,849**	**4031,105**
13	0	70,504	852,096	41,702	1,675	2096,251	243,075	75,520	10,616	0,456	64,508	125,959	0,013	**922,60**	**2659,775**	**3582,375**
13,5	1,770	123,611	747,412	36,578	1,469	1073,219	213,212	0	0	1,554	28,338	94,401	0,020	**872,793**	**1448,791**	**2321,584**
14	9,998	291,509	685,48	33,547	1,347	725,770	195,545	0	0	0	19,342	63,978	0,016	**986,987**	**1039,545**	**2026,532**
14,5	11,247	579,360	280,585	13,732	0,551	405,849	80,041	0	0	0	0	34,254	0,013	**871,192**	**534,440**	**1405,632**
15	37,811	709,114	197,214	9,652	0,388	70,452	56,259	0	0	0	0	3,819	0,020	**944,139**	**140,59**	**1084,729**
15,5	87,242	525,814	59,080	2,891	0,116	0	16,854	0	0	0	0	25,727	0,107	**672,136**	**45,695**	**717,831**
16	131,511	305,242	11,437	0,560	0,022	0	3,263	0	0	0	0	38,193	0,347	**448,190**	**42,385**	**490,575**
16,5	152,795	161,15	0	0	0	0	0	0	0	0	0	63,490	0,240	**313,945**	**63,730**	**377,675**
17	57,593	102,615	0	0	0	0	0	0	0	0	0	46,832	0,142	**160,208**	**46,974**	**207,182**
17,5	38,097	23,956	0	0	0	0	0	0	0	0	0	0	0,024	**62,053**	**0,024**	**62,077**
18	13,963	0	0	0	0	0	0	0	0	0	0	0	0,005	**13,963**	**0,005**	**13,968**
18,5	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
19	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
19,5	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
20	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
TOTAL	**542,027**	**2914,513**	**4316,152**	**211,234**	**8,482**	**21431,338**	**1231,256**	**11562,716**	**1338,784**	**41,193**	**639,340**	**648,898**	**0,963**	**7772,692**	**37114,204**	**44886,896**

Table 6. *ECOCADIZ 2020-07* survey. Sardine (*S. pilchardus*). Estimated abundance (absolute numbers and million fish) and biomass (t) by size class (in cm). Polygons (*i.e.*, coherent or homogeneous post-strata) numbered as in **Figure 20**.

ECOCADIZ 2020-07. Sardina pilchardus . ABUNDANCE (in numbers and million fish)														
Size class	POL01	POL02	POL03	POL04	POL05	POL06	POL07	POL08	*n*			Millions		
									PORTUGAL	SPAIN	TOTAL	PORTUGAL	SPAIN	TOTAL
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8,5	0	56277	0	0	1983	861394	0	0	58260	861394	919654	0,1	1	1
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	2972384	0	0	2972384	2972384	0	3	3
10,5	0	0	0	0	0	0	25997500	0	0	25997500	25997500	0	26	26
11	0	47205	0	784338	1664	722534	49511572	3509973	833207	53744079	54577286	1	54	55
11,5	0	112554	0	784338	3967	1722788	41040571	5263513	900859	48026872	48927731	1	48	49
12	0	1218858	0	3137353	42955	18656221	20982522	20472434	4399166	60111177	64510343	4	60	65
12,5	0	4479513	0	9412060	157866	68564803	20750372	26320460	14049439	115635635	129685074	14	116	130
13	0	11811053	0	17998500	416241	180783616	10371664	28661407	30225794	219816687	250042481	30	220	250
13,5	0	13582593	0	17214162	478673	207899349	2398964	13452487	31275428	223750800	255026228	31	224	255
14	0	13978913	793166	32116589	492640	213965543	1023687	4679000	47381308	219668230	267049538	47	220	267
14,5	0	6375330	3993660	23488868	224677	97582762	1613	584513	34082535	98168888	132251423	34	98	132
15	0	3869368	4800741	13581437	136363	59225742	3226	584513	22387909	59813481	82201390	22	60	82
15,5	0	3435416	3993660	14200651	121070	52583539	281868	0	21750797	52865407	74616204	22	53	75
16	17864	3287435	9601483	23571430	115855	50318498	4840	0	36594067	50323338	86917405	37	50	87
16,5	17864	1939505	23196625	47762074	68351	29686655	8838	0	72984419	29695493	102679912	73	30	103
17	38519	2892676	62381807	53169881	101943	44276185	3226	0	118584826	44279411	162864237	119	44	163
17,5	160775	1882807	44793004	27121593	66353	28818825	32968	0	74024532	28851793	102876325	74	29	103
18	228323	1324772	21596378	11517389	46687	20277374	157838	0	34713549	20435212	55148761	35	20	55
18,5	254561	304981	6400988	0	10748	4668139	45805	0	6971278	4713944	11685222	7	5	12
19	192595	304981	0	0	10748	4668139	24970	0	508324	4693109	5201433	1	5	5
19,5	159659	182804	0	660495	6442	2798050	168290	0	1009400	2966340	3975740	1	3	4
20	121140	91633	793166	0	3229	1402567	176288	0	1009168	1578855	2588023	1	2	3
20,5	38519	0	0	0	0	0	3226	0	38519	3226	41745	0,04	0,003	0,04
21	74247	30544	0	0	1076	467522	0	0	105867	467522	573389	0,1	0,5	1
21,5	17864	0	0	0	0	0	0	0	17864	0	17864	0,02	0	0,02
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL *n*	1321930	71209218	182344678	296521158	2509531	1089950245	175962232	103528300	553906515	1369440777	1923347292	**554**	**1369**	**1923**
Millions	**1**	**71**	**182**	**297**	**3**	**1090**	**176**	**104**	**554**	**1369**	**1923**			

Table 6. *ECOCADIZ 2020-07* survey. Sardine (*S. pilchardus*). Cont'd.

ECOCADIZ 2020-07 . Sardina pilchardus . BIOMASS (t)											
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	**POL06**	**POL07**	**POL08**	**PORTUGAL**	**SPAIN**	**TOTAL**
6	0	0	0	0	0	0	0	0	0	0	0
6,5	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0
7,5	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0
8,5	0	0,262	0	0	0,009	4,014	0	0	0,271	4,014	4,285
9	0	0	0	0	0	0	0	0	0	0	0
9,5	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	23,121	0	0	23,121	23,121
10,5	0	0	0	0	0	0	235,951	0	0	235,951	235,951
11	0	0,496	0	8,248	0,017	7,598	520,633	36,909	8,761	565,14	573,901
11,5	0	1,363	0	9,495	0,048	20,855	496,813	63,717	10,906	581,385	592,291
12	0	16,886	0	43,466	0,595	258,469	290,698	283,631	60,947	832,798	893,745
12,5	0	70,644	0	148,433	2,490	1081,301	327,244	415,087	221,567	1823,632	2045,199
13	0	210,974	0	321,497	7,435	3229,24	185,263	511,963	539,906	3926,466	4466,372
13,5	0	273,537	0	346,672	9,640	4186,84	48,312	270,917	629,849	4506,069	5135,918
14	0	316,037	17,932	726,096	11,138	4837,359	23,144	105,783	1071,203	4966,286	6037,489
14,5	0	161,163	100,956	593,780	5,680	2466,813	0,041	14,776	861,579	2481,63	3343,209
15	0	108,964	135,193	382,464	3,840	1667,844	0,091	16,460	630,461	1684,395	2314,856
15,5	0	107,397	124,849	443,938	3,785	1643,857	8,812	0	679,969	1652,669	2332,638
16	0,618	113,716	332,127	815,364	4,008	1740,576	0,167	0	1265,833	1740,743	3006,576
16,5	0,682	74,007	885,135	1822,501	2,608	1132,781	0,337	0	2784,933	1133,118	3918,051
17	1,617	121,409	2618,231	2231,597	4,279	1858,319	0,135	0	4977,133	1858,454	6835,587
17,5	7,402	86,684	2062,261	1248,673	3,055	1326,813	1,518	0	3408,075	1328,331	4736,406
18	11,501	66,733	1087,881	580,169	2,352	1021,438	7,951	0	1748,636	1029,389	2778,025
18,5	13,996	16,768	351,932	0	0,591	256,658	2,518	0	383,287	259,176	642,463
19	11,531	18,260	0	0	0,644	279,490	1,495	0	30,435	280,985	311,420
19,5	10,387	11,892	0	42,969	0,419	182,028	10,948	0	65,667	192,976	258,643
20	8,545	6,464	55,951	0	0,228	98,939	12,436	0	71,188	111,375	182,563
20,5	2,940	0	0	0	0	0	0,246	0	2,940	0,246	3,186
21	6,122	2,519	0	0	0,089	38,551	0	0	8,730	38,551	47,281
21,5	1,588	0	0	0	0	0	0	0	1,588	0	1,588
22	0	0	0	0	0	0	0	0	0	0	0
22,5	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0
TOTAL	**76,929**	**1786,175**	**7772,448**	**9765,362**	**62,950**	**27339,783**	**2197,874**	**1719,243**	**19463,864**	**31256,900**	**50720,764**

Table 7. *ECOCADIZ 2020-07* survey. Chub mackerel (*S. colias*). Estimated abundance (absolute numbers and million fish) and biomass (t) by size class (in cm). Polygons (*i.e.*, coherent or homogeneous post-strata) numbered as in **Figure 23**.

ECOCADIZ 2020-07 . *Scomber colias* . ABUNDANCE (in numbers and million fish)																						
Size class	POL01	POL02	POL03	POL04	POL05	POL06	POL07	POL08	POL09	POL10	POL11	POL12	POL13	POL14	POL15	POL16	*n*			Millions		
																	PORTUGAL	SPAIN	TOTAL	PORTUGAL	SPAIN	TOTAL
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	428	0	0	124055	0	0	0	0	0	0	0	428	124055	124483	0,0004	0,1	0,1
15,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	52	0	0	15033	0	0	0	0	0	0	11649	52	26682	26734	0,0001	0,03	0,03
16,5	0	0	0	0	0	685	0	0	198479	0	0	148759	4786	0	5261	11649	685	368934	369619	0,001	0,4	0,4
17	0	0	0	0	39116	4486	238	5037	1299820	77901	0	487382	46392	0	50998	210846	43602	2178614	2222216	0,04	2	2
17,5	0	95316	0	651000	219560	12320	1335	28272	3569576	437260	0	1484894	112310	594425	123461	703997	978196	7055530	8033726	1	7	8
18	0	1743636	0	11908856	233270	10617	1418	30037	3076136	464564	0	1129418	54224	743031	59608	830139	13896379	6388575	20284954	14	6	20
18,5	26807	5492780	191056	37515138	284271	6752	1728	36604	1956188	566133	0	1172895	45849	0	50401	472811	43516804	4302609	47819413	44	4	48
19	104387	6131310	743961	41876232	563994	4488	3429	72623	1300324	1123210	0	1091868	67250	222909	73927	497587	49424372	4453127	53877499	49	4	54
19,5	64175	5408247	457377	36937785	1013779	2816	6163	130540	816022	2018969	0	834592	105538	222909	116017	357934	43884179	4608684	48492863	44	5	48
20	387896	4285188	2764524	29267405	1236974	2655	7520	159280	769336	2463468	0	719539	114567	297212	125942	330201	37944642	4987065	42931707	38	5	43
20,5	377335	2536701	2689259	17325411	1545437	1185	9395	198999	343426	3077781	0	526118	115356	58447	126810	107663	24475328	4563995	29039323	24	5	29
21	706742	2955182	5036934	20183595	1627417	2235	9894	209555	647591	3241045	0	212933	117885	161974	129589	116310	30512105	4846776	35358881	31	5	35
21,5	931762	2076842	6640647	14184626	1793013	1467	10900	230878	425167	3570835	0	336253	114024	191198	125345	55287	25628357	5059887	30688244	26	5	31
22	1170186	2030946	8339888	13871159	2268651	2325	13792	292124	673755	4518081	0	372329	97680	775670	107379	104661	27683155	6955471	34638626	28	7	35
22,5	1571486	1018565	11199940	6956694	2311233	1776	14051	297607	514627	4602883	51563	354291	96212	1197410	105765	31990	23059694	7266399	30326093	23	7	30
23	1510154	406579	10762827	2776894	1705637	2673	10369	219627	774542	3396824	92814	445090	71247	1683332	78321	31990	17164764	6804156	23968920	17	7	24
23,5	642567	108728	4579557	742604	1132240	1317	6883	145793	381660	2254886	237192	171827	61268	1338383	67351	0	7207013	4665243	11872256	7	5	12
24	385865	47658	2750050	325500	644187	1198	3916	82949	347065	1282917	237192	166797	32687	823238	35933	0	4154458	3012694	7167152	4	3	7
24,5	248984	0	1774506	0	492473	993	2994	63414	287566	980774	185628	123319	26976	1016923	29655	0	2516956	2717249	5234205	3	3	5
25	120634	0	859752	0	326740	307	1986	42073	89087	650711	92814	0	17676	220421	19431	0	1307433	1134199	2441632	1	1	2
25,5	40211	0	286584	0	98278	307	597	12655	89087	195722	185628	23068	7043	533489	7743	0	425380	1055032	1480412	0,4	1	1
26	26807	0	191056	0	155499	0	945	20023	0	309680	51563	64175	2393	236277	2631	0	373362	687687	1061049	0,4	1	1
26,5	64175	0	457377	0	84756	0	515	10914	0	168795	288755	0	0	161974	0	0	606308	630953	1237261	1	1	1
27	26807	0	191056	0	107056	0	651	13785	0	213206	237192	0	0	177830	0	0	324919	642664	967583	0,3	1	1
27,5	64175	47658	457377	325500	0	0	0	0	0	0	185628	0	0	116895	0	0	894710	302523	1197233	1	0,3	1
28	0	0	0	0	56504	0	344	7276	0	112530	330006	0	0	148606	0	0	56504	598762	655266	0,1	1	1
28,5	0	0	0	0	0	0	0	0	0	0	237192	0	0	74303	0	0	0	311495	311495	0	0,3	0,3
29	0	0	0	0	0	0	0	0	0	0	804389	0	0	0	0	10170	0	814559	814559	0	1	1
29,5	0	0	0	0	0	0	0	0	0	0	618761	0	0	148606	0	0	0	767367	767367	0	1	1
30	0	0	0	0	0	0	0	0	0	0	474383	0	0	74303	0	0	0	548686	548686	0	1	0,5
30,5	0	0	0	0	0	0	0	0	0	0	1051893	0	0	0	0	0	0	1051893	1051893	0	1	1
31	0	0	0	0	0	0	0	0	0	0	670324	0	0	0	0	0	0	670324	670324	0	1	1
31,5	0	0	0	0	0	0	0	0	0	0	433133	0	0	0	0	0	0	433133	433133	0	0,4	0,4
32	0	0	0	0	0	0	0	0	0	0	185628	0	0	0	0	0	0	185628	185628	0	0,2	0,2
32,5	0	0	0	0	0	0	0	0	0	0	567197	0	0	0	0	0	0	567197	567197	0	1	1
33	0	0	0	0	0	0	0	0	0	0	567197	0	0	0	0	0	0	567197	567197	0	1	1
33,5	0	0	0	0	0	0	0	0	0	0	185628	0	0	0	0	0	0	185628	185628	0	0,2	0,2
34	0	0	0	0	0	0	0	0	0	0	92814	0	0	0	0	0	0	92814	92814	0	0,1	0,1
34,5	0	0	0	0	0	0	0	0	0	0	144378	0	0	0	0	0	0	144378	144378	0	0,1	0,1
35	0	0	0	0	0	0	0	0	0	0	92814	0	0	148606	0	0	0	241420	241420	0	0,2	0,2
35,5	0	0	0	0	0	0	0	0	0	0	92814	0	0	74303	0	0	0	167117	167117	0	0,2	0,2
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL *n*	8471155	34385336	60373728	234848399	17940085	61082	109063	2310065	17698542	35728175	8394520	9865547	1311363	11442674	1441568	3884884	356079785	92186401	448266186	**356**	**92**	**448**
Millions	**8**	**34**	**60**	**235**	**18**	**0,1**	**0,1**	**2**	**18**	**36**	**8**	**10**	**1**	**11**	**1**	**4**						

Table 7. *ECOCADIZ 2020-07* survey. Chub mackerel (*S. colias*). Cont'd.

ECOCADIZ 2019-07 . Scomber colias . BIOMASS (t)																			
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	**POL06**	**POL07**	**POL08**	**POL09**	**POL10**	**POL11**	**POL12**	**POL13**	**POL14**	**POL15**	**POL16**	**PORTUGAL**	**SPAIN**	**TOTAL**
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0,011	0	0	3,096	0	0	0	0	0	0	0	0,011	3,096	3,107
15,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0,002	0	0	0,461	0	0	0	0	0	0	0,357	0,002	0,818	0,820
16,5	0	0	0	0	0	0,023	0	0	6,715	0	0	5,033	0,162	0	0,178	0,394	0,023	12,482	12,505
17	0	0	0	0	1,456	0,167	0,009	0,187	48,378	2,899	0	18,140	1,727	0	1,898	7,847	1,623	81,085	82,708
17,5	0	3,892	0	26,583	8,965	0,503	0,055	1,154	145,758	17,855	0	60,633	4,586	24,272	5,041	28,747	39,943	288,101	328,044
18	0	77,913	0	532,135	10,423	0,474	0,063	1,342	137,454	20,759	0	50,467	2,423	33,202	2,664	37,094	620,945	285,468	906,413
18,5	1,308	267,930	9,319	1829,935	13,866	0,329	0,084	1,785	95,420	27,615	0	57,212	2,236	0	2,458	23,063	2122,687	209,873	2332,56
19	5,546	325,730	39,523	2224,701	29,963	0,238	0,182	3,858	69,081	59,671	0	58,006	3,573	11,842	3,927	26,435	2625,701	236,575	2862,276
19,5	3,705	312,237	26,406	2132,549	58,529	0,163	0,356	7,537	47,112	116,562	0	48,184	6,093	12,869	6,698	20,665	2533,589	266,076	2799,665
20	24,286	268,299	173,089	1832,456	77,448	0,166	0,471	9,973	48,169	154,240	0	45,051	7,173	18,609	7,885	20,674	2375,744	312,245	2687,989
20,5	25,570	171,902	182,240	1174,072	104,728	0,080	0,637	13,485	23,273	208,569	0	35,653	7,817	3,961	8,593	7,296	1658,592	309,284	1967,876
21	51,739	216,341	368,741	1477,588	119,139	0,164	0,724	15,341	47,408	237,268	0	15,588	8,630	11,858	9,487	8,515	2233,712	354,819	2588,531
21,5	73,557	163,954	524,238	1119,789	141,547	0,116	0,860	18,226	33,564	281,895	0	26,545	9,001	15,094	9,895	4,365	2023,201	399,445	2422,646
22	99,447	172,598	708,757	1178,826	192,799	0,198	1,172	24,826	57,258	383,964	0	31,642	8,301	65,920	9,125	8,895	2352,625	591,103	2943,728
22,5	143,534	93,032	1022,963	635,400	211,100	0,162	1,283	27,182	47,004	420,411	4,710	32,360	8,788	109,367	9,660	2,922	2106,191	663,687	2769,878
23	148,010	39,849	1054,866	272,164	167,170	0,262	1,016	21,526	75,913	332,923	9,097	43,623	6,983	164,984	7,676	3,135	1682,321	666,876	2349,197
23,5	67,478	11,418	480,916	77,984	118,901	0,138	0,723	15,310	40,079	236,794	24,908	18,044	6,434	140,548	7,073	0	756,835	489,913	1246,748
24	43,354	5,355	308,984	36,572	72,378	0,135	0,440	9,320	38,995	144,143	26,650	18,741	3,673	92,496	4,037	0	466,778	338,495	805,273
24,5	29,890	0	213,022	0	59,119	0,119	0,359	7,613	34,521	117,738	22,284	14,804	3,238	122,077	3,560	0	302,150	326,194	628,344
25	15,452	0	110,128	0	41,853	0,039	0,254	5,389	11,411	83,351	11,889	0	2,264	28,234	2,489	0	167,472	145,281	312,753
25,5	5,489	0	39,120	0	13,415	0,042	0,081	1,727	12,161	26,717	25,339	3,149	0,961	72,824	1,057	0	58,066	144,016	202,082
26	3,895	0	27,759	0	22,593	0	0,137	2,909	0	44,994	7,492	9,324	0,348	34,329	0,382	0	54,247	99,915	154,162
26,5	9,913	0	70,647	0	13,092	0	0,080	1,686	0	26,072	44,602	0	0	25,019	0	0	93,652	97,459	191,111
27	4,397	0	31,338	0	17,560	0	0,107	2,261	0	34,971	38,905	0	0	29,169	0	0	53,295	105,413	158,708
27,5	11,166	8,292	79,579	56,634	0	0	0	0	0	0	32,297	0	0	20,339	0	0	155,671	52,636	208,307
28	0	0	0	0	10,417	0	0,063	1,341	0	20,747	60,842	0	0	27,398	0	0	10,417	110,391	120,808
28,5	0	0	0	0	0	0	0	0	0	0	46,291	0	0	14,501	0	0	0	60,792	60,792
29	0	0	0	0	0	0	0	0	0	0	166,017	0	0	0	0	2,099	0	168,116	168,116
29,5	0	0	0	0	0	0	0	0	0	0	134,924	0	0	32,404	0	0	0	167,328	167,328
30	0	0	0	0	0	0	0	0	0	0	109,188	0	0	17,102	0	0	0	126,290	126,29
30,5	0	0	0	0	0	0	0	0	0	0	255,336	0	0	0	0	0	0	255,336	255,336
31	0	0	0	0	0	0	0	0	0	0	171,454	0	0	0	0	0	0	171,454	171,454
31,5	0	0	0	0	0	0	0	0	0	0	116,640	0	0	0	0	0	0	116,640	116,64
32	0	0	0	0	0	0	0	0	0	0	52,587	0	0	0	0	0	0	52,587	52,587
32,5	0	0	0	0	0	0	0	0	0	0	168,906	0	0	0	0	0	0	168,906	168,906
33	0	0	0	0	0	0	0	0	0	0	177,415	0	0	0	0	0	0	177,415	177,415
33,5	0	0	0	0	0	0	0	0	0	0	60,943	0	0	0	0	0	0	60,943	60,943
34	0	0	0	0	0	0	0	0	0	0	31,961	0	0	0	0	0	0	31,961	31,961
34,5	0	0	0	0	0	0	0	0	0	0	52,110	0	0	0	0	0	0	52,110	52,11
35	0	0	0	0	0	0	0	0	0	0	35,088	0	0	56,180	0	0	0	91,268	91,268
35,5	0	0	0	0	0	0	0	0	0	0	36,728	0	0	29,403	0	0	0	66,131	66,131
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	**767,736**	**2138,742**	**5471,635**	**14607,388**	**1506,461**	**3,531**	**9,156**	**193,978**	**1023,231**	**3000,158**	**1924,603**	**592,199**	**94,411**	**1214,001**	**103,783**	**202,503**	**24495,493**	**8358,023**	**32853,516**

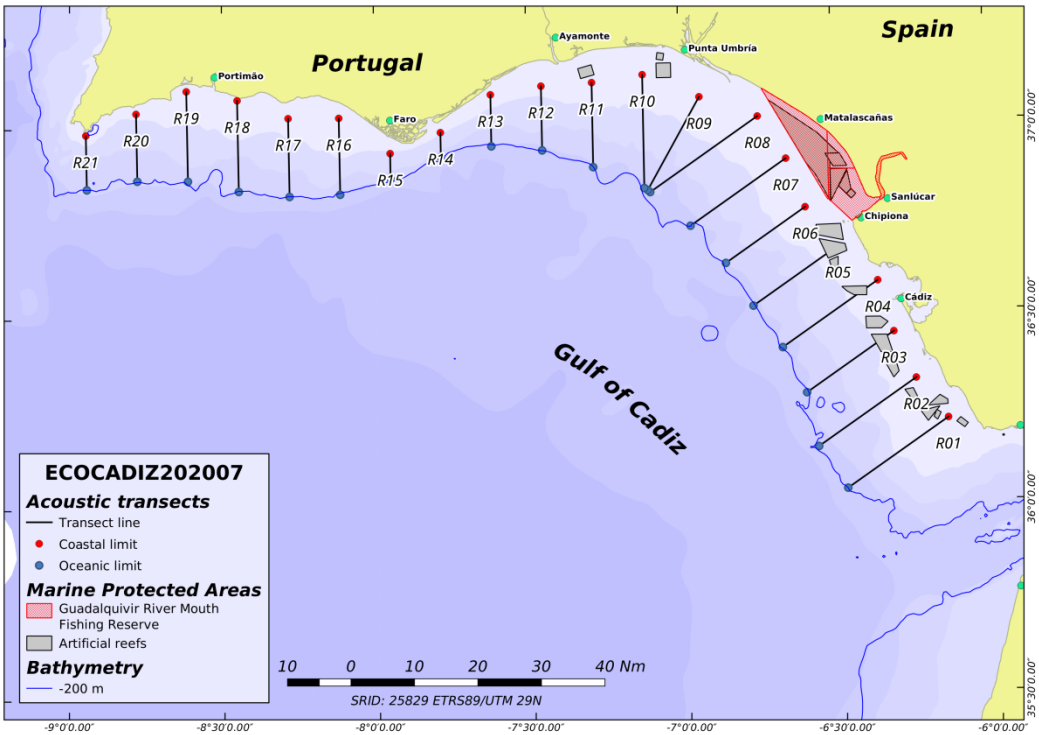


Figure 1. *ECOCADIZ 2020-07* survey. Location of the acoustic transects sampled during the survey. The different protected areas inside the Guadalquivir river mouth Fishing Reserve and artificial reef polygons are also shown.

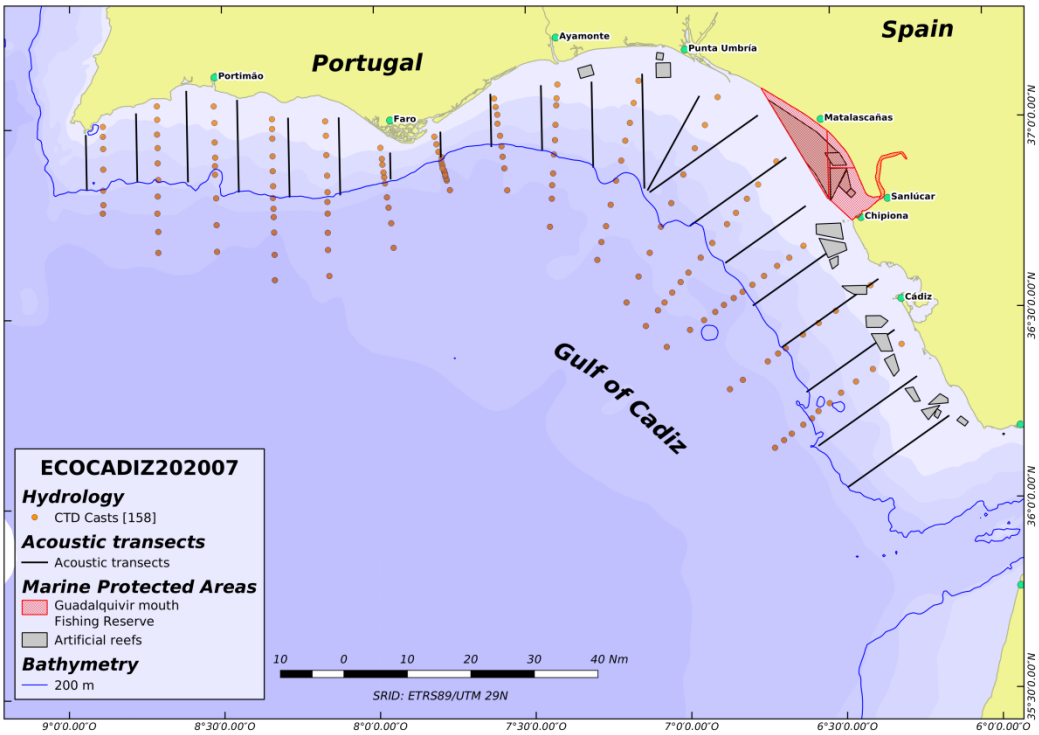


Figure 2. *ECOCADIZ 2020-07* survey. Location of CTD-LADCP stations.

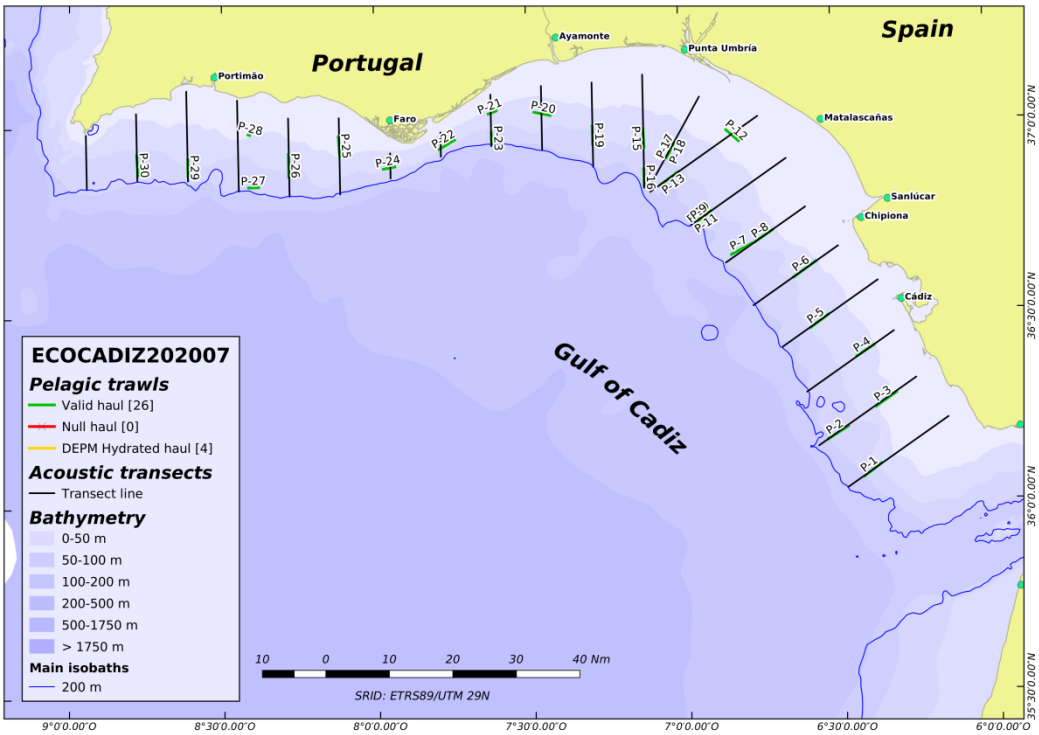


Figure 3. *ECOCADIZ 2020-07* survey. Location of ground-truthing fishing hauls.

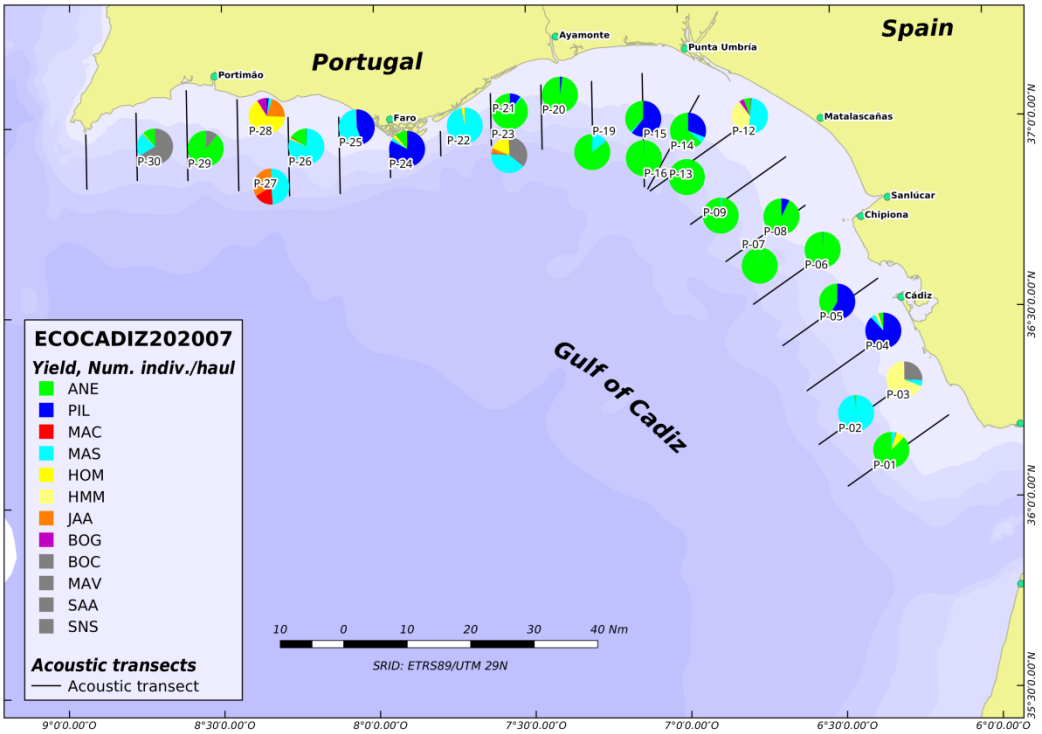


Figure 4. *ECOCADIZ 2020-07* survey. Species composition (percentages in number) in fishing hauls.

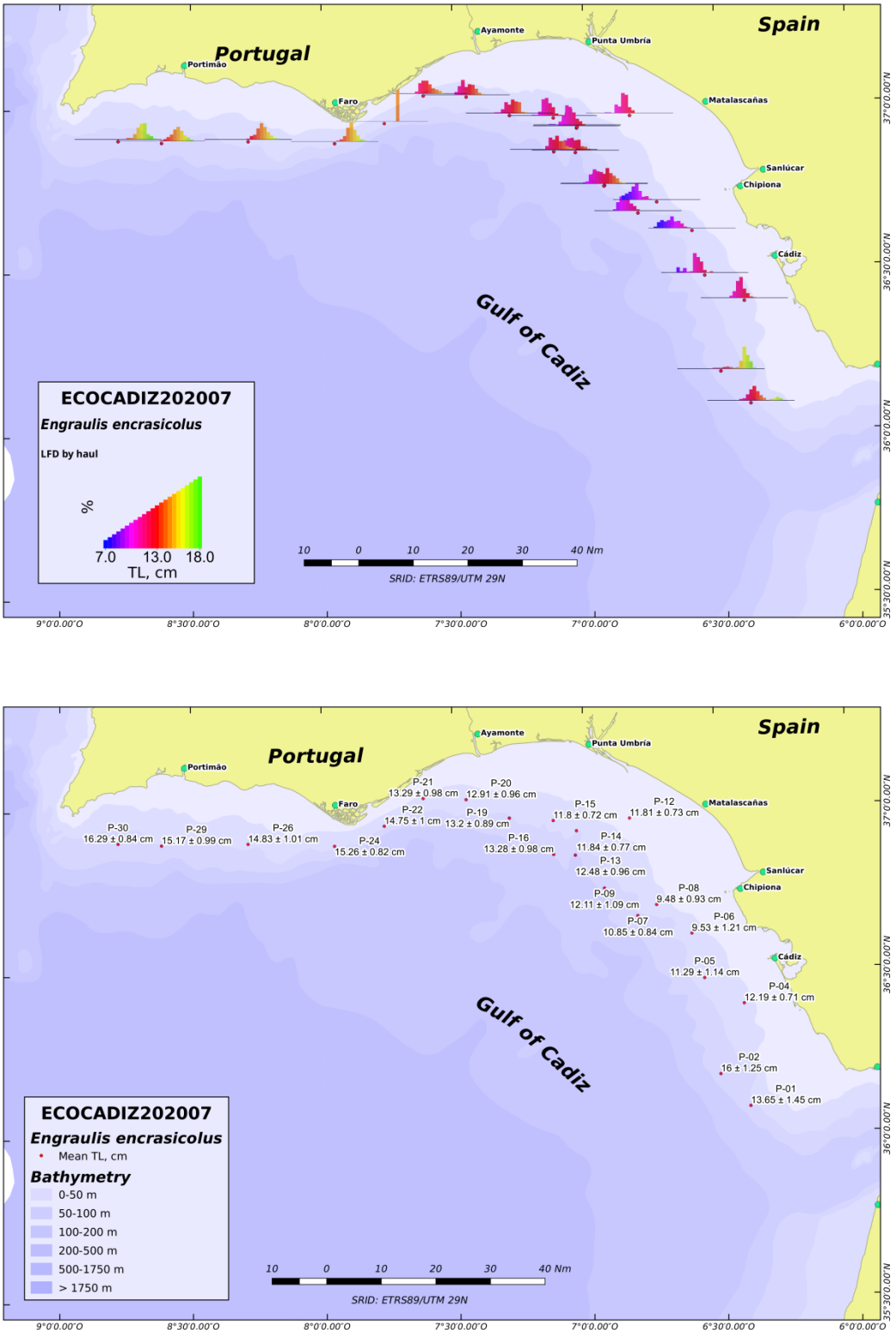


Figure 5. *ECOCADIZ 2020-07* survey. *Engraulis encrasicolus*. Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

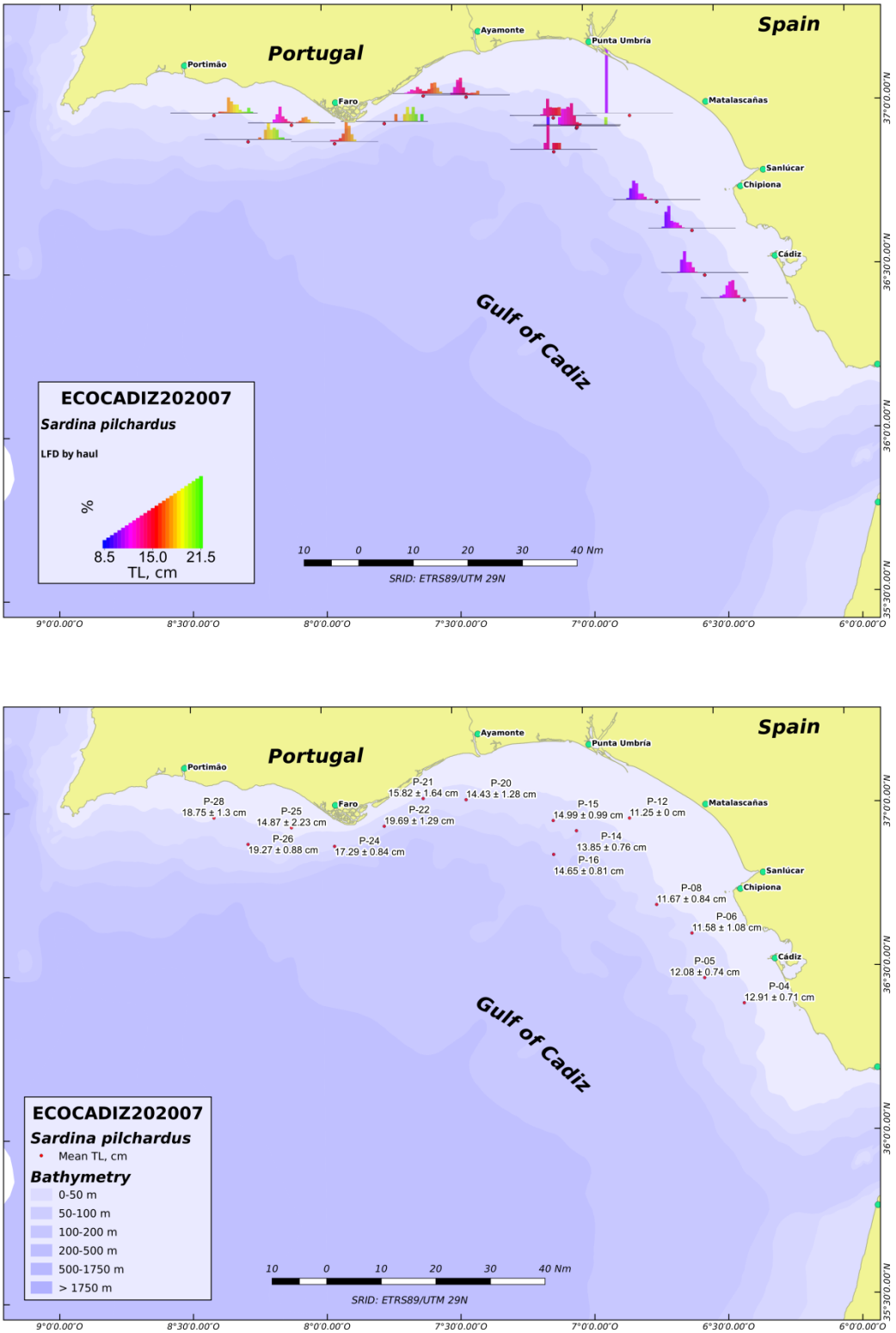


Figure 6. *ECOCADIZ 2020-07* survey. *Sardina pilchardus*. Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

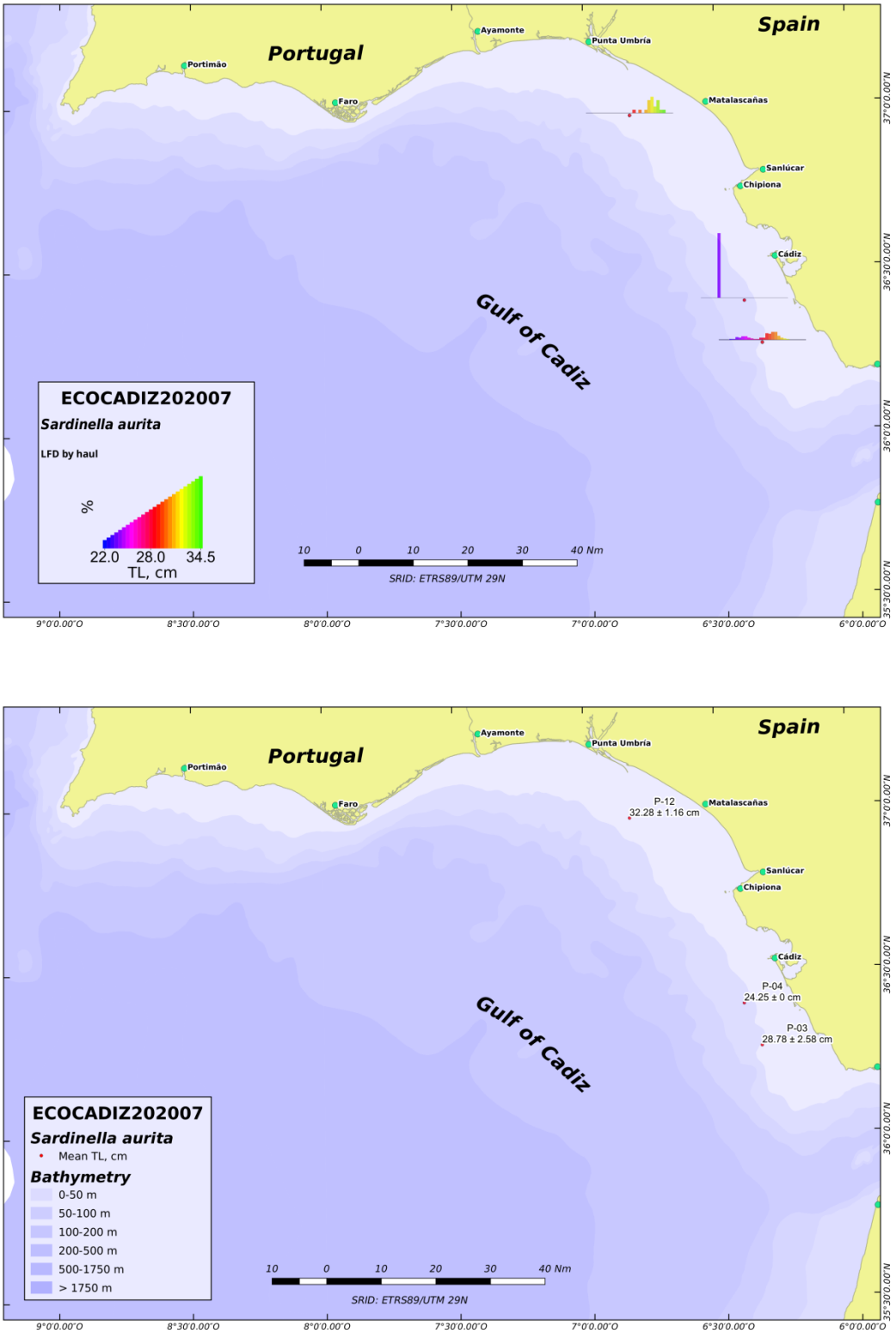


Figure 7. *ECOCADIZ 2020-07* survey. *Sardinella aurita*. Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

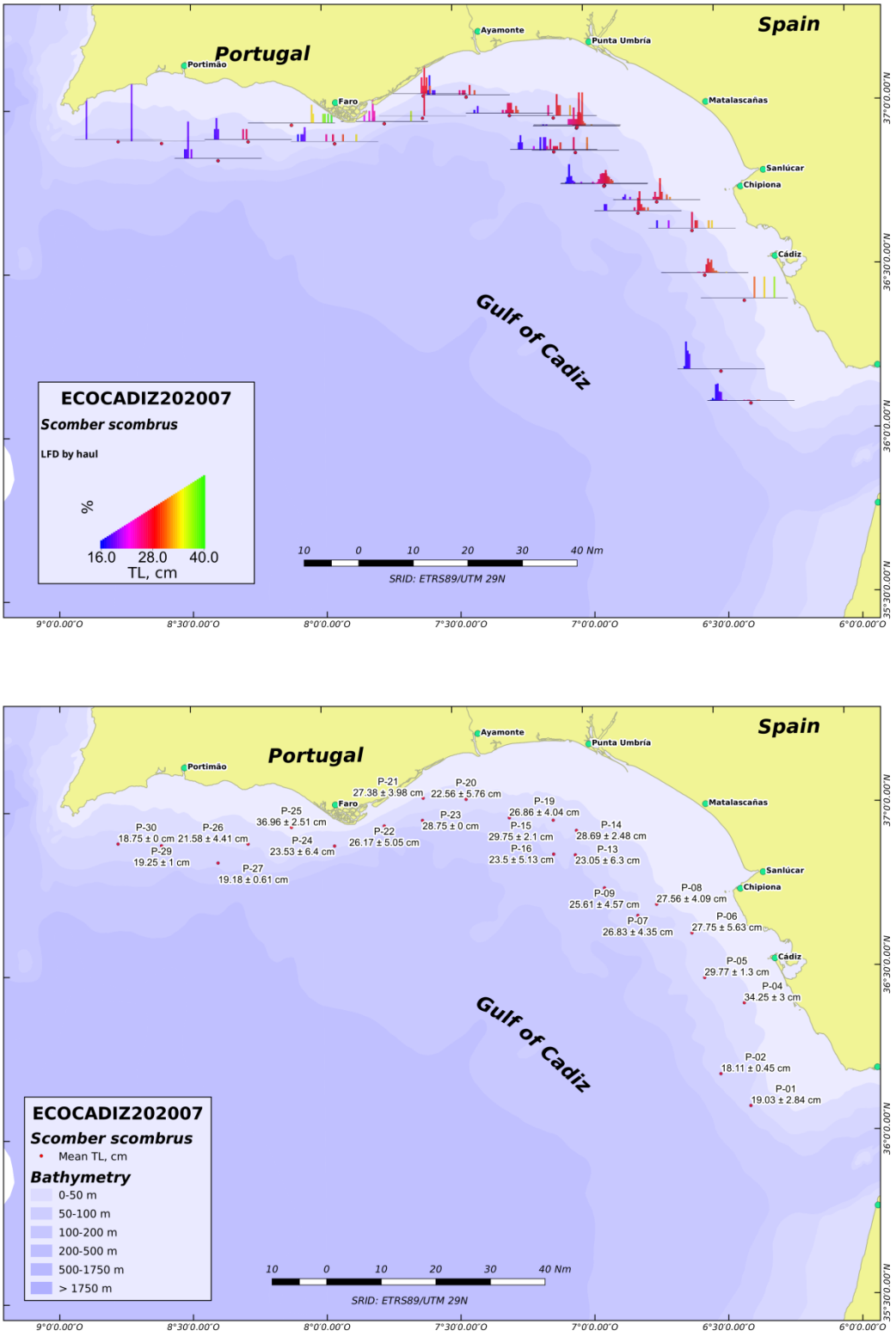


Figure 8. *ECOCADIZ 2020-07* survey. *Scomber scombrus*. Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

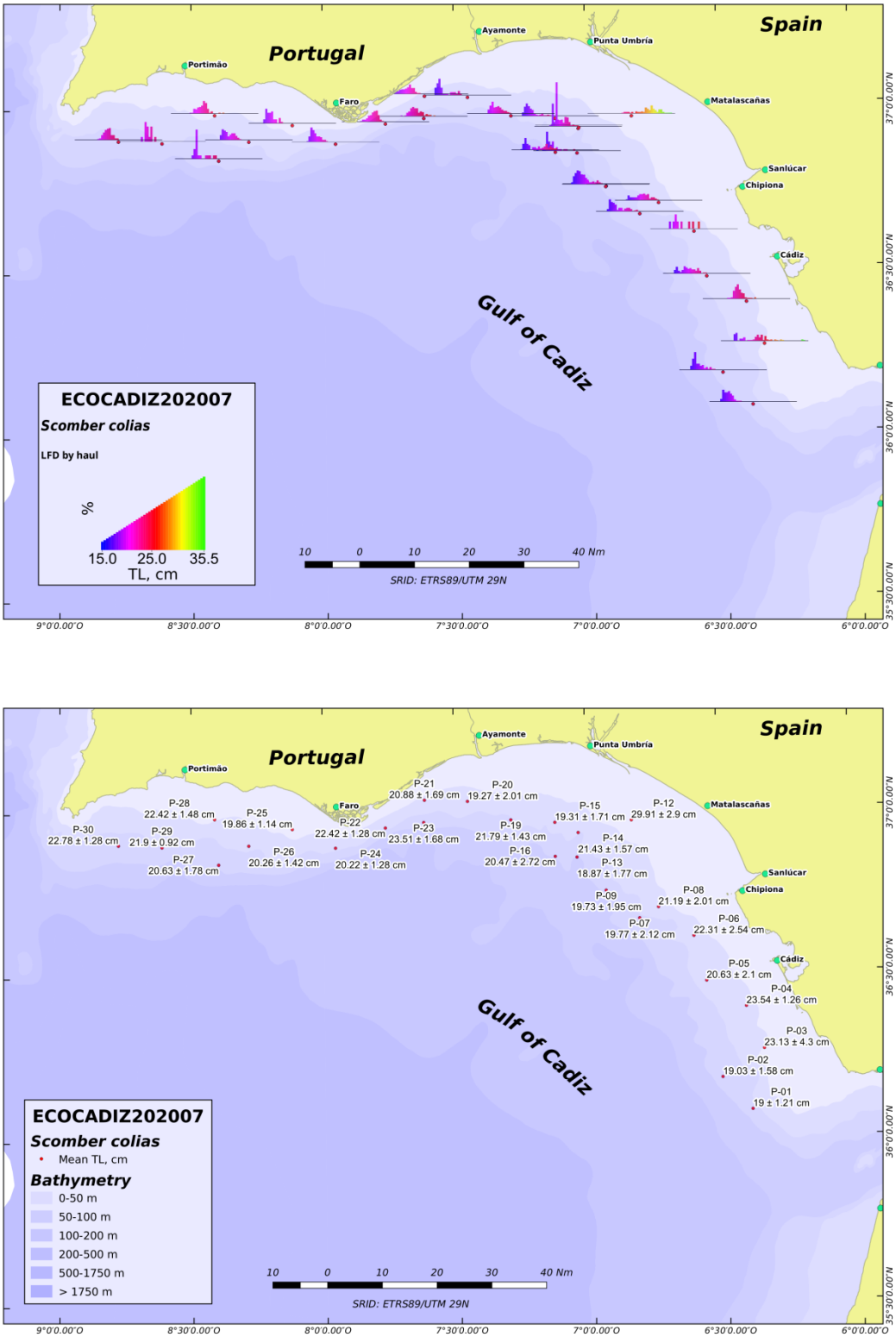


Figure 9. *ECOCADIZ 2020-07* survey. *Scomber colias*. Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

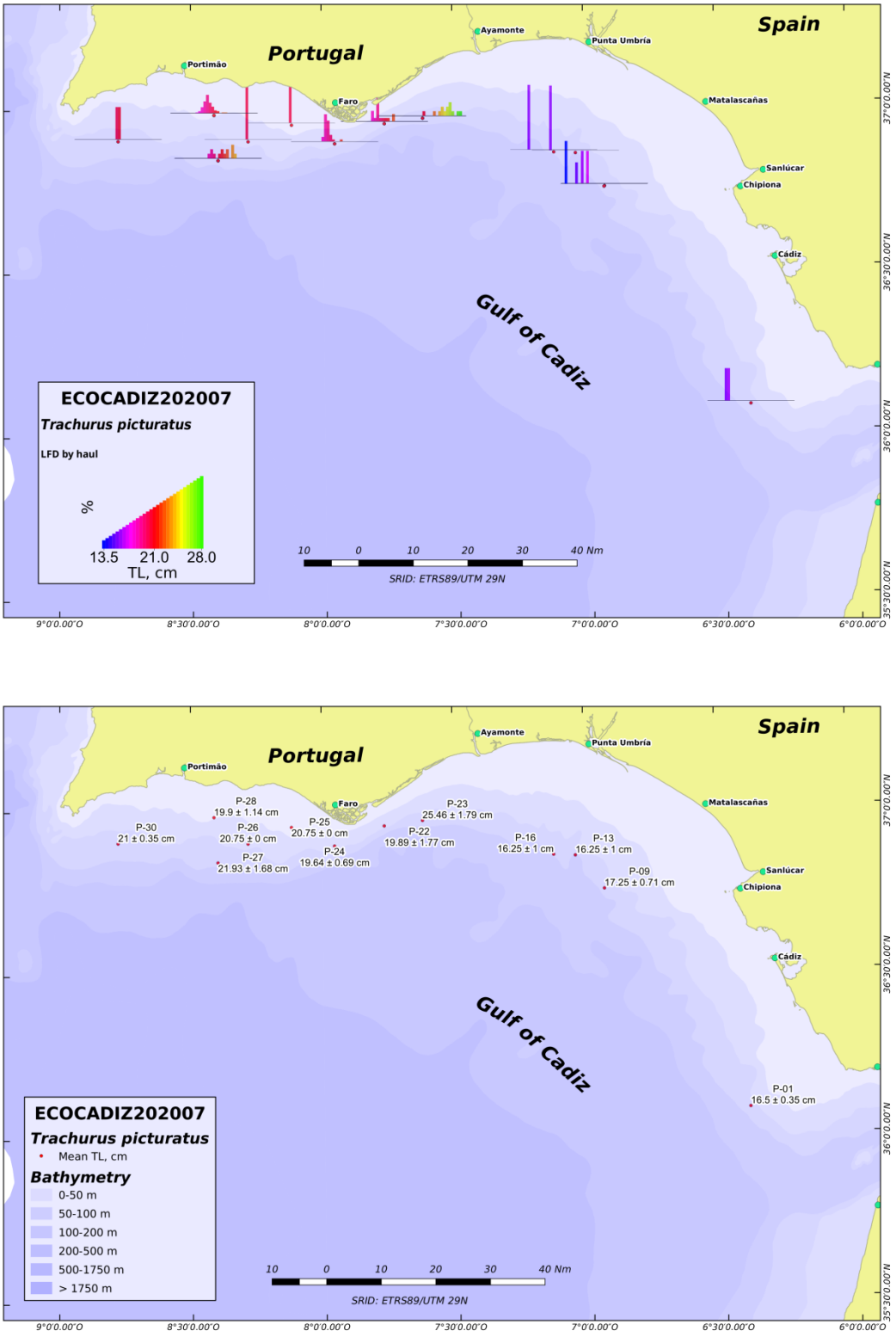


Figure 10. *ECOCADIZ 2020-07* survey. *Trachurus picturatus*. Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

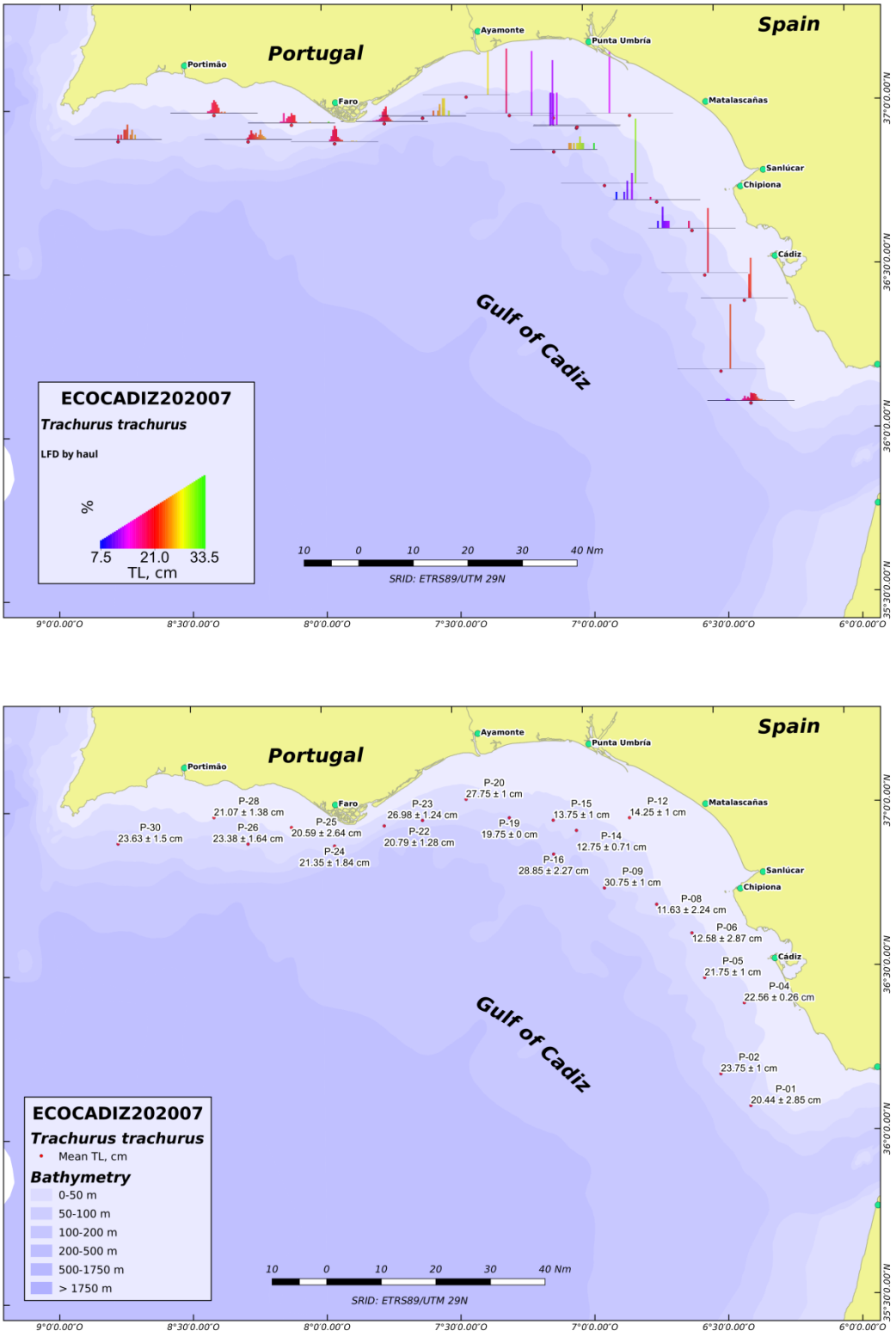


Figure 11. *ECOCADIZ 2020-07* survey. *Trachurus trachurus*. Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

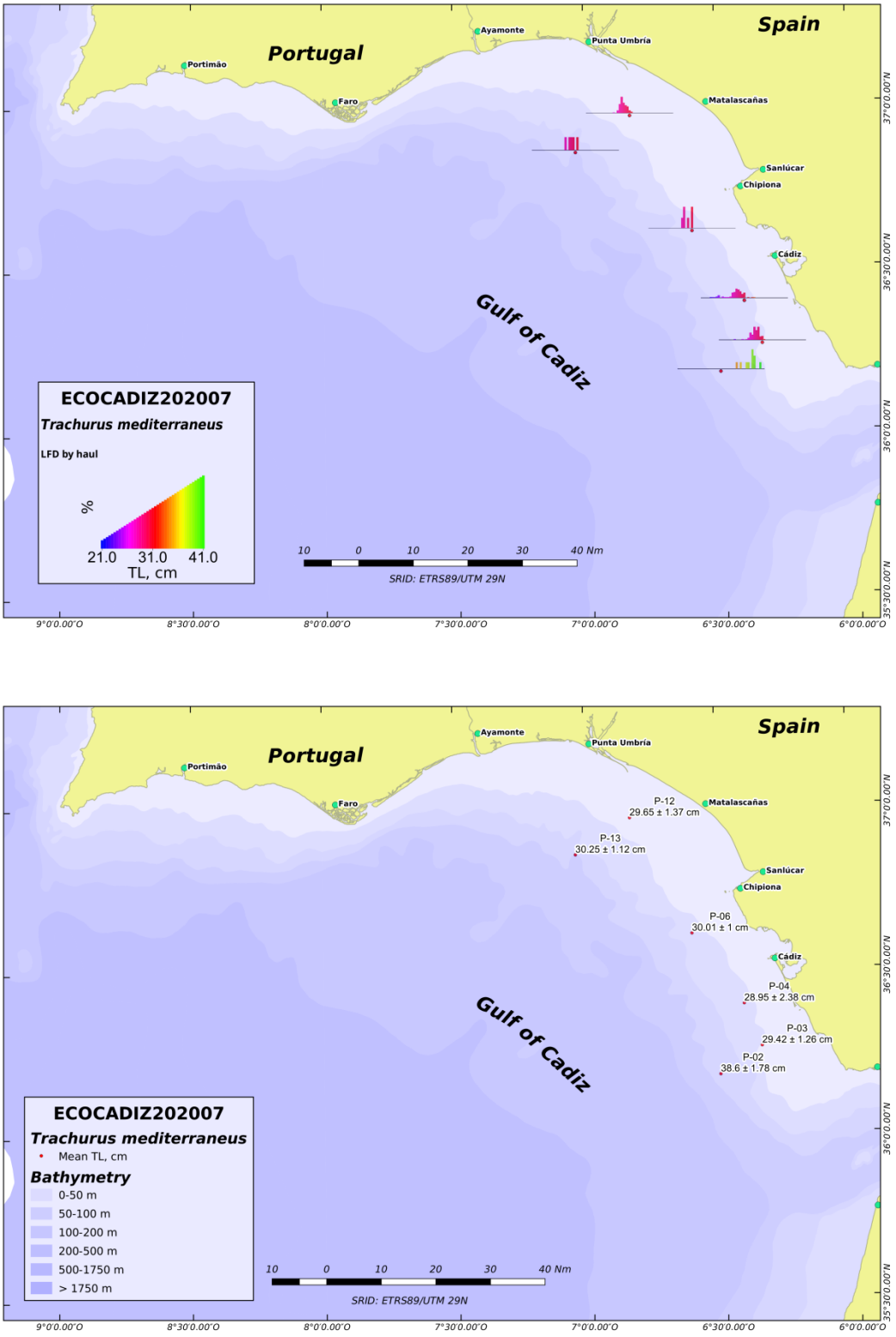
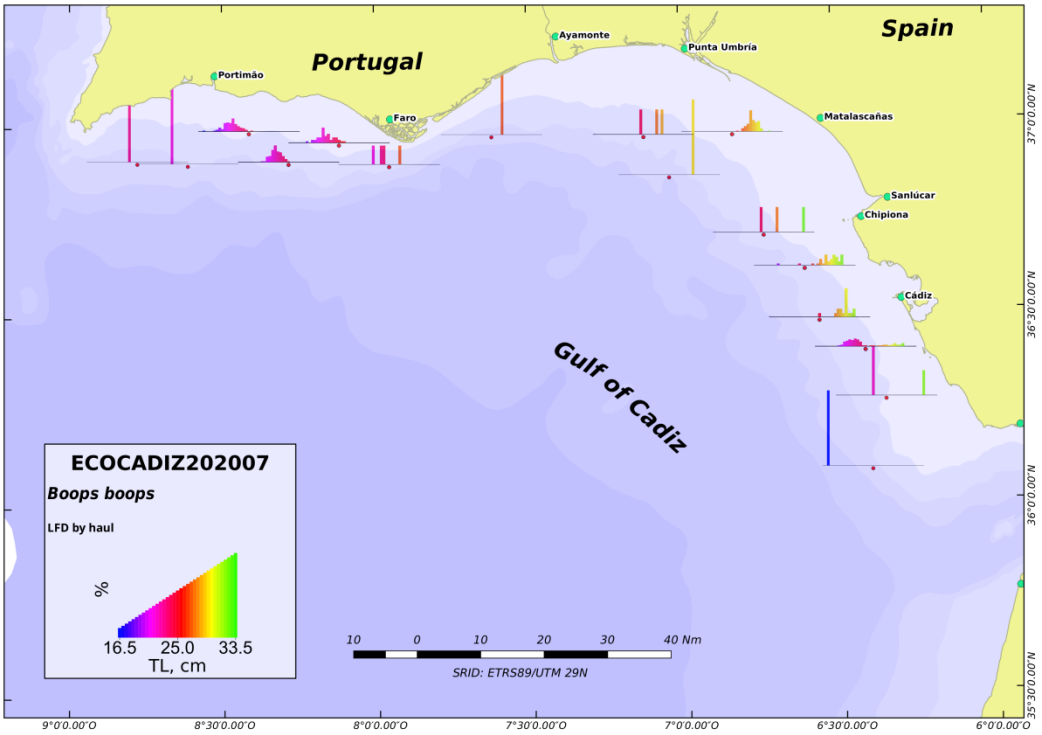


Figure 12. *ECOCADIZ 2020-07* survey. *Trachurus mediterraneus*. Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.



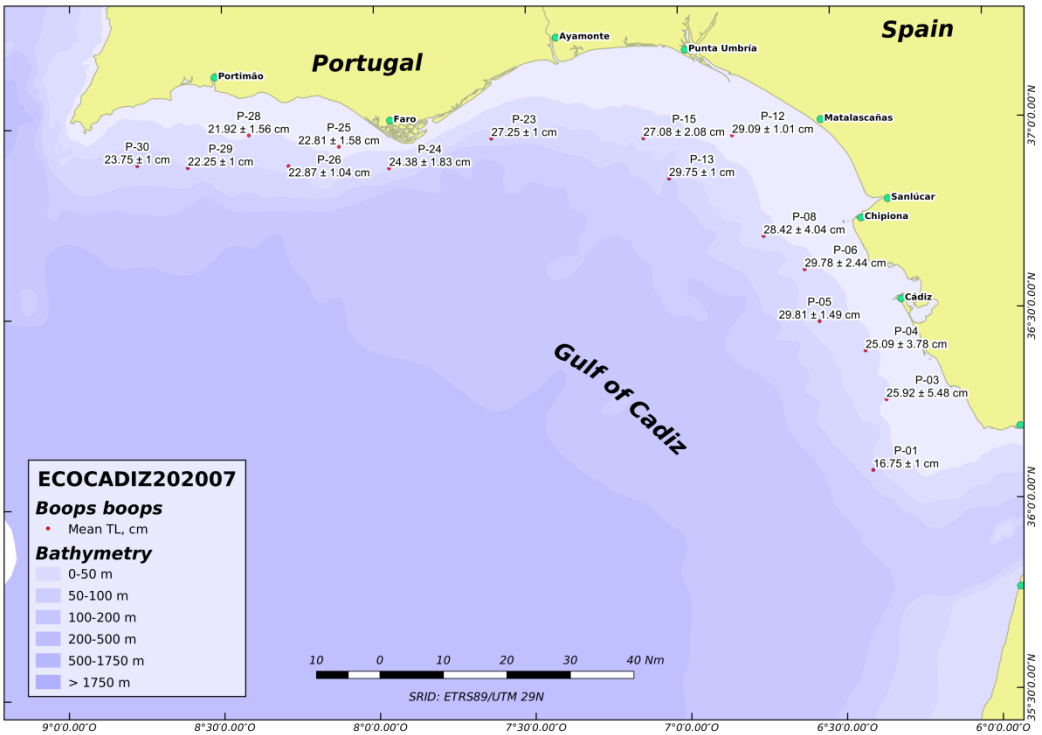
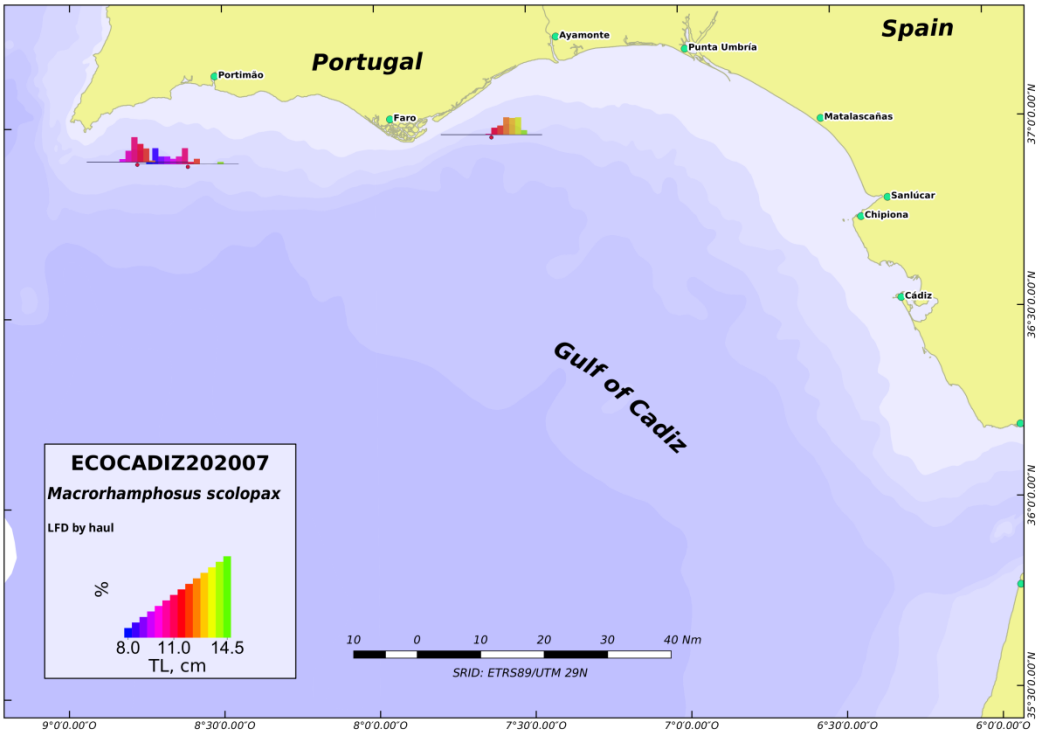


Figure 13. *ECOCADIZ 2020-07* survey. *Boops boops*. Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.



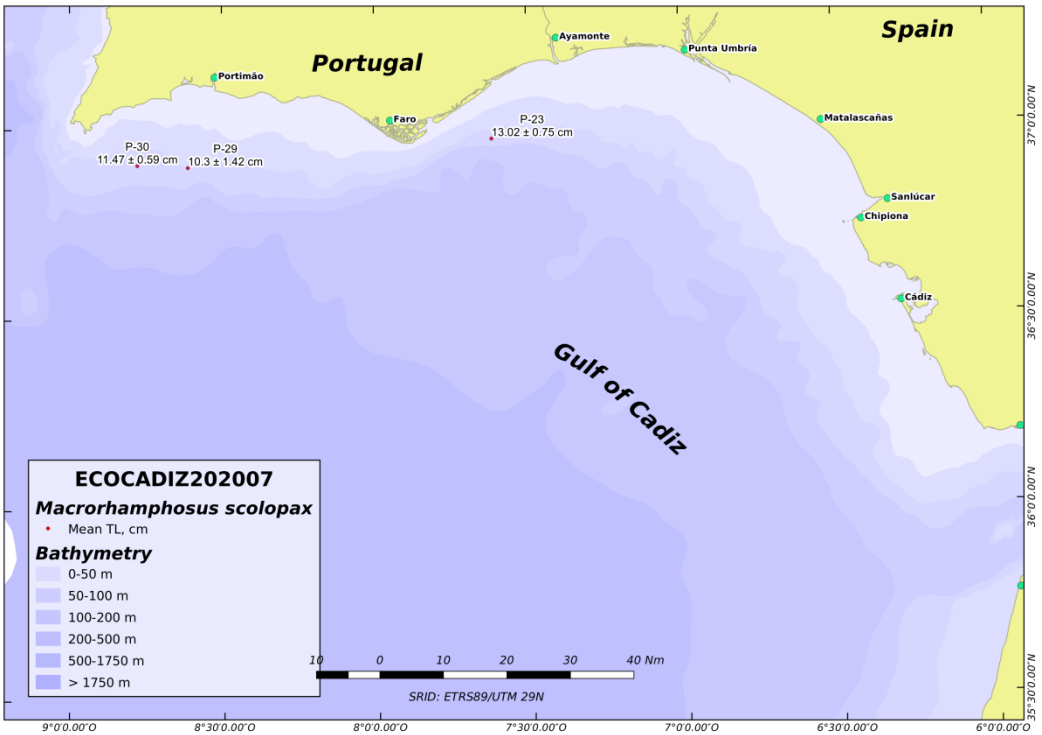
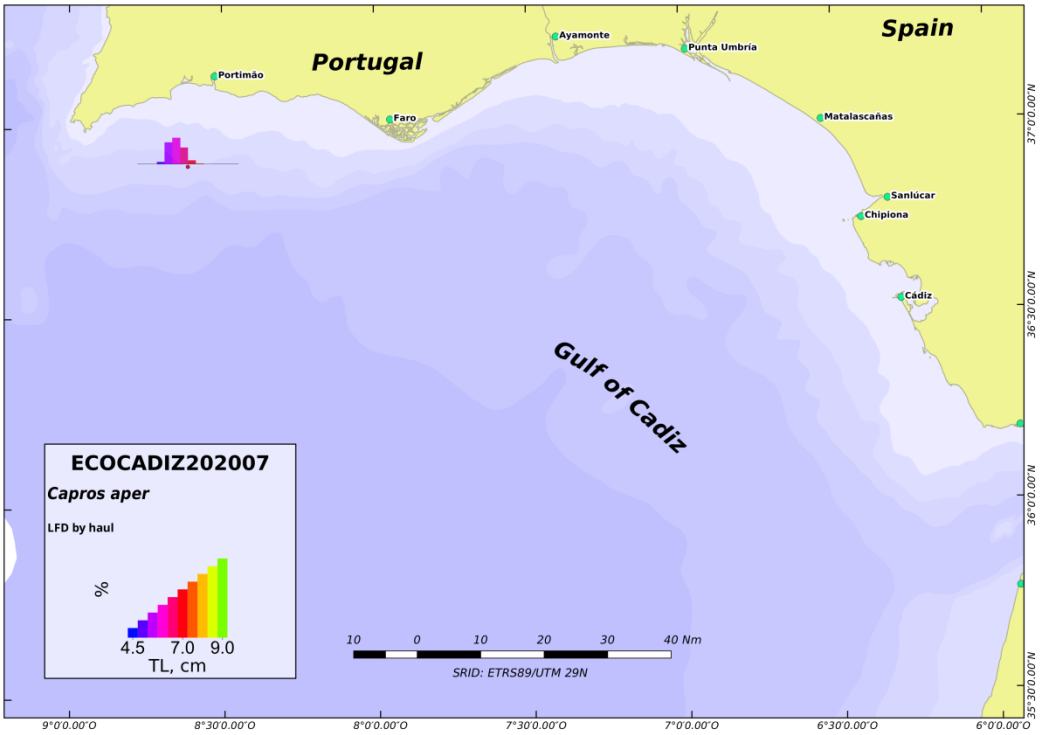


Figure 14. *ECOCADIZ 2020-07* survey. *Macrorhamphosus scolopax*. Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.



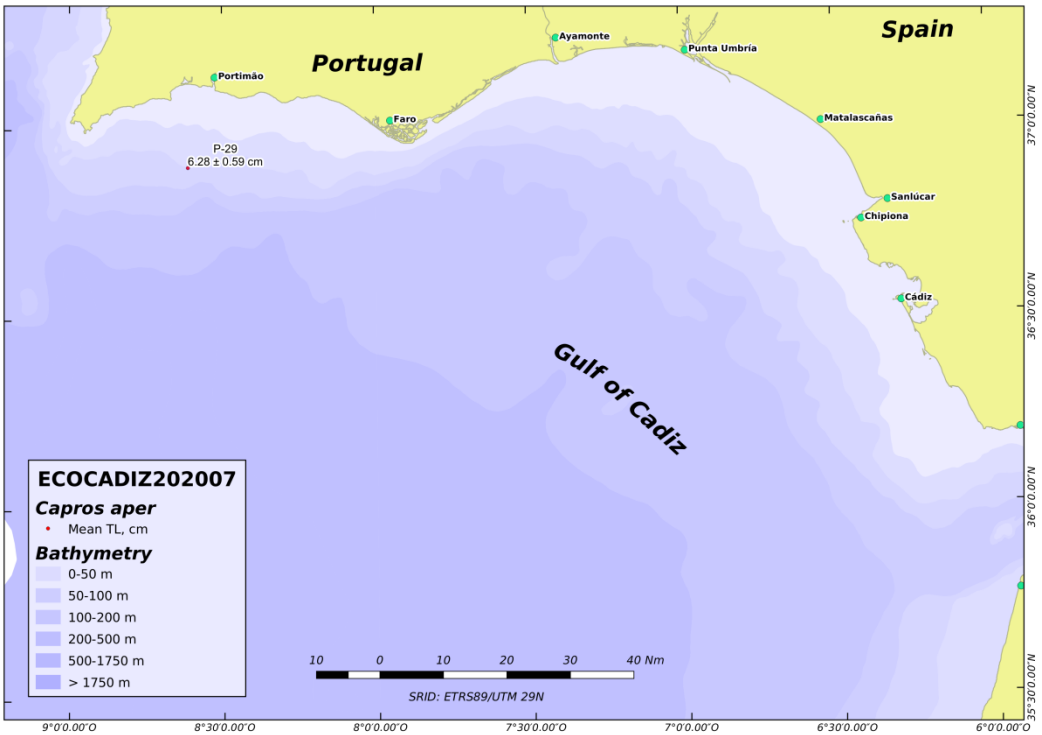


Figure 15. *ECOCADIZ 2020-07* survey. *Capros aper*. Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

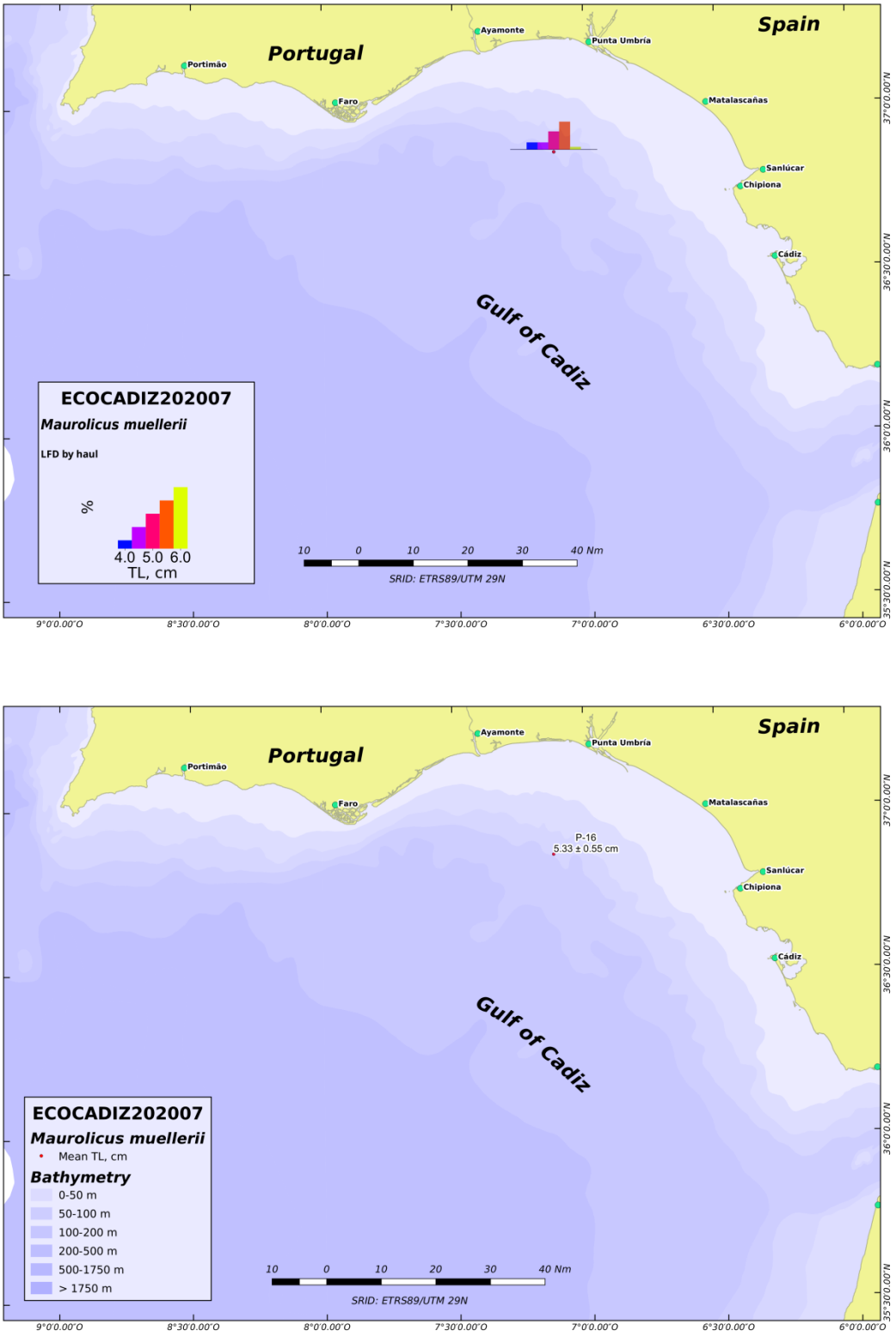


Figure 16. *ECOCADIZ 2020-07* survey. *Maurolicus muelleri*. Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

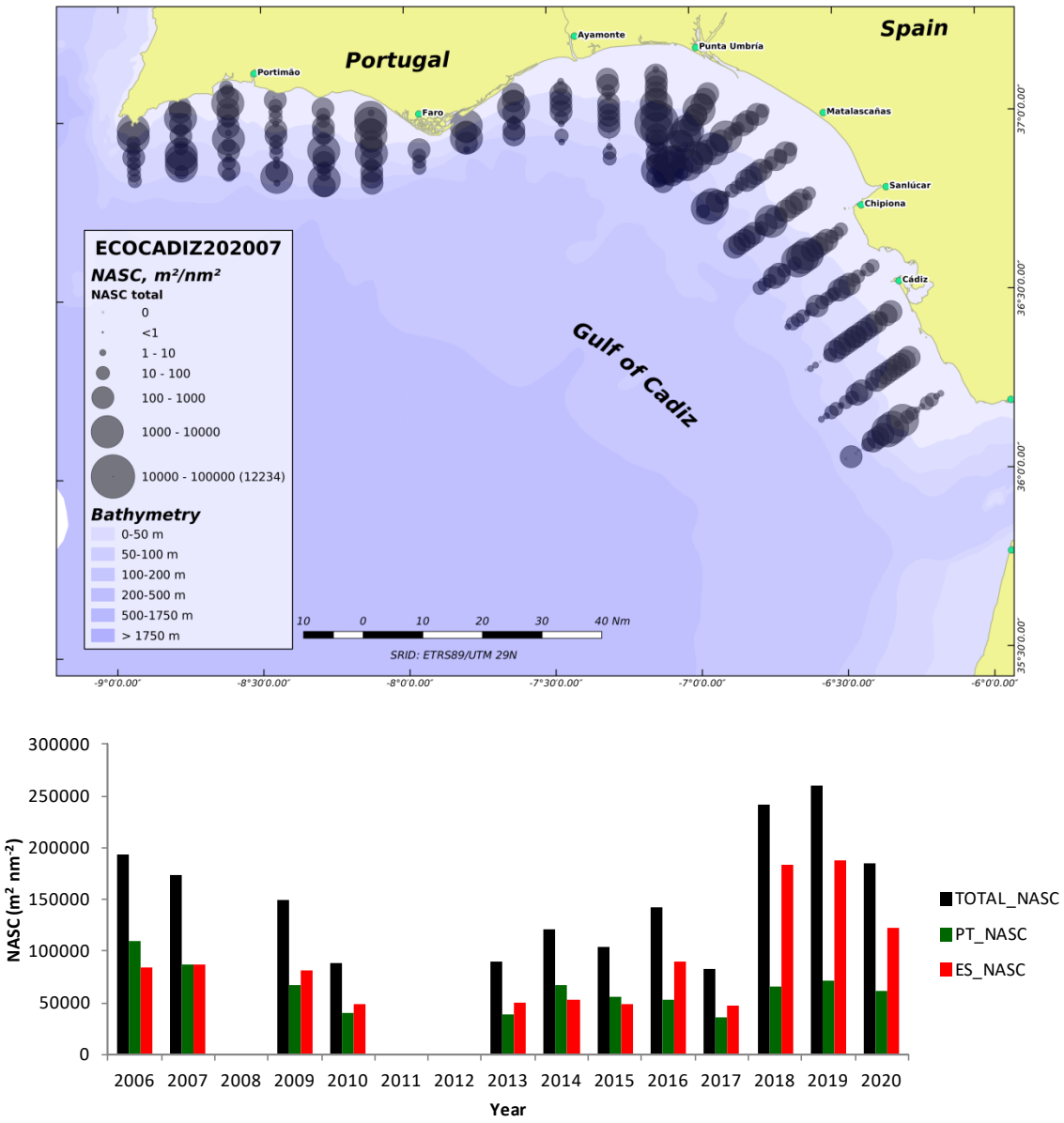


Figure 17. *ECOCADIZ 2020-07* survey. Top: distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the pelagic fish species assemblage. Bottom: time-series of total NASC estimates per survey.

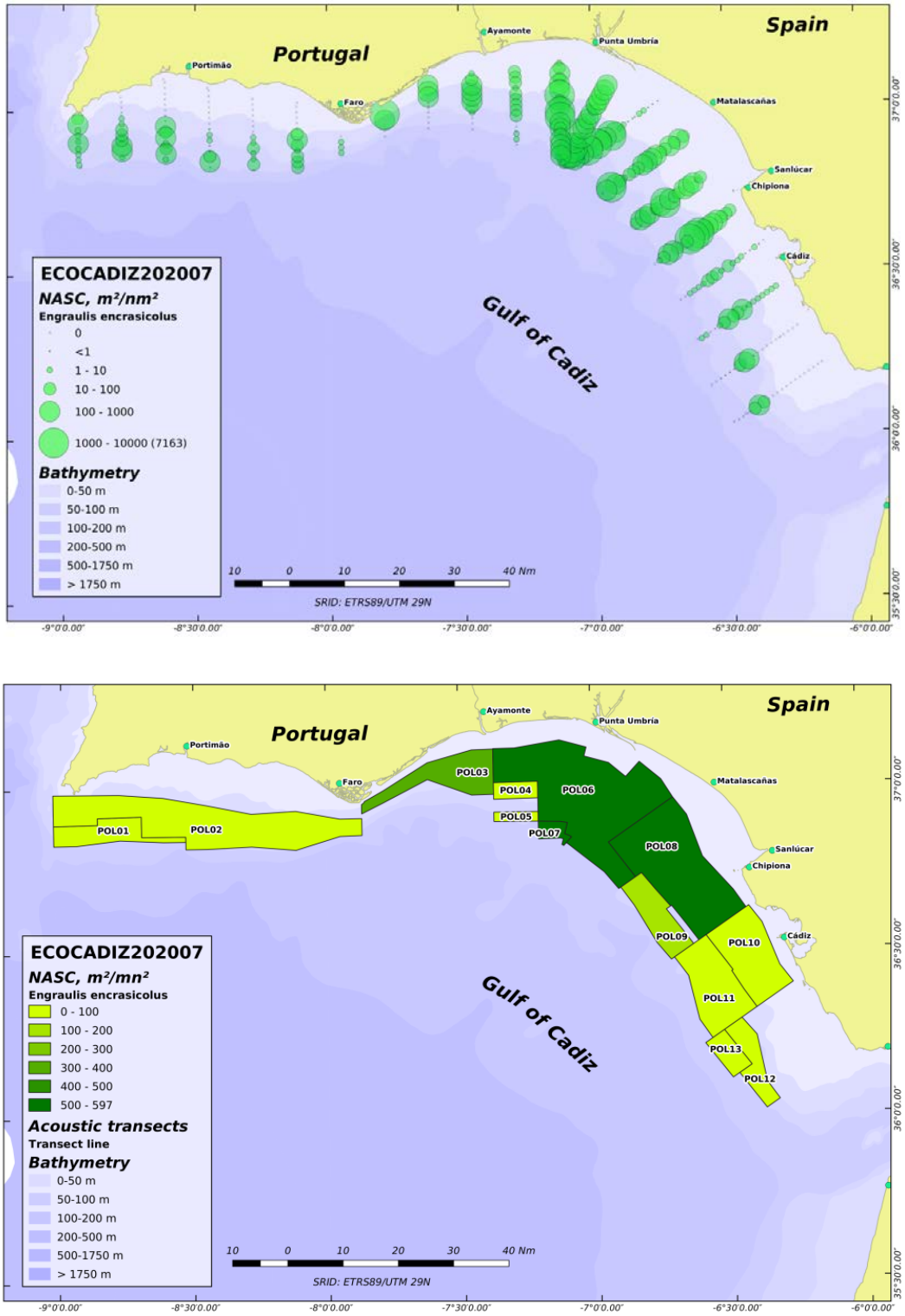


Figure 18. *ECOCADIZ 2020-07* survey. Anchovy (*Engraulis encrasicolus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

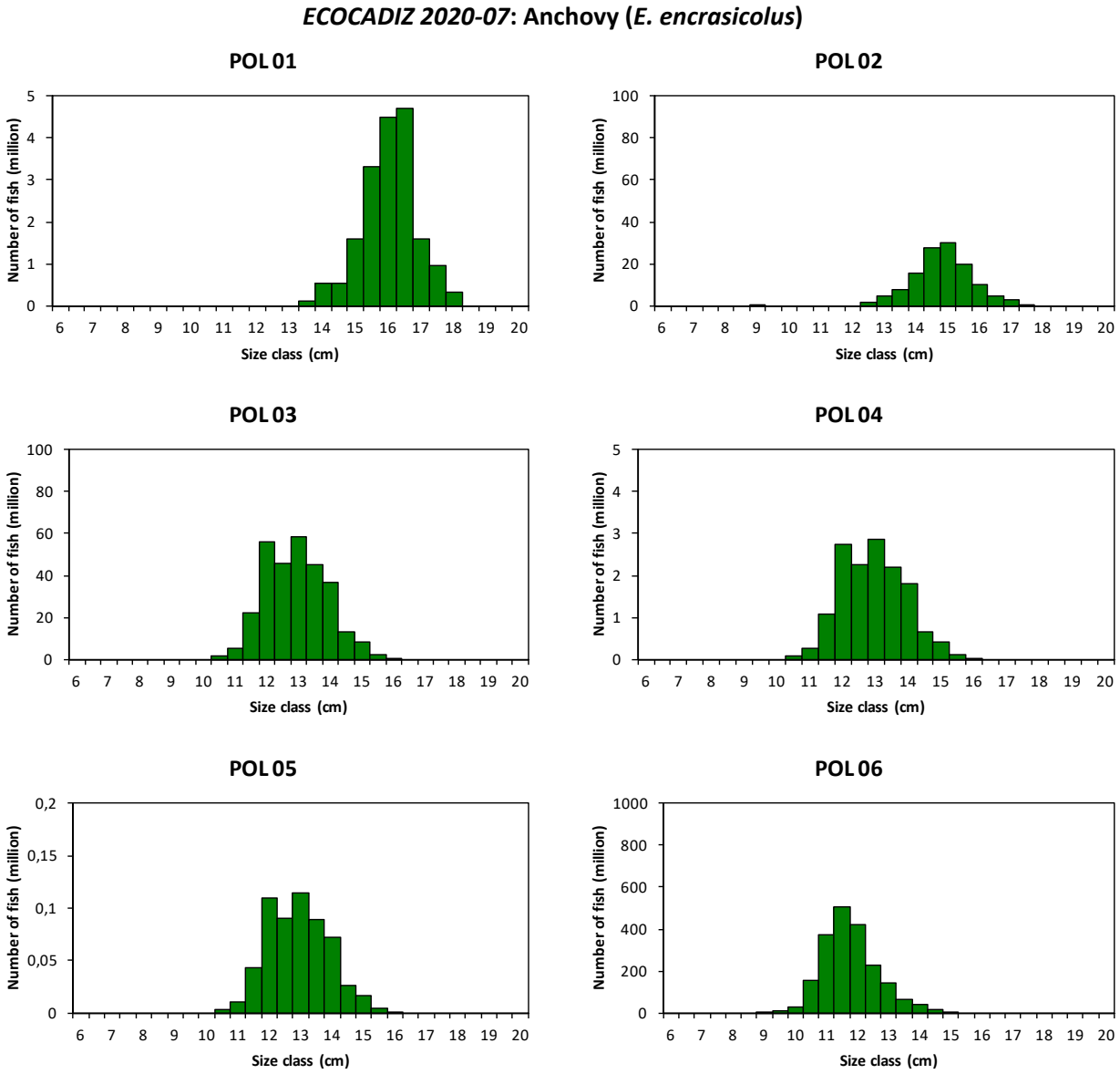


Figure 19. *ECOCADIZ 2020-07* survey. Anchovy (*E. encrasicolus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous stratum (POL01-POLn, numeration as in **Figure 18**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scales in the y axis.

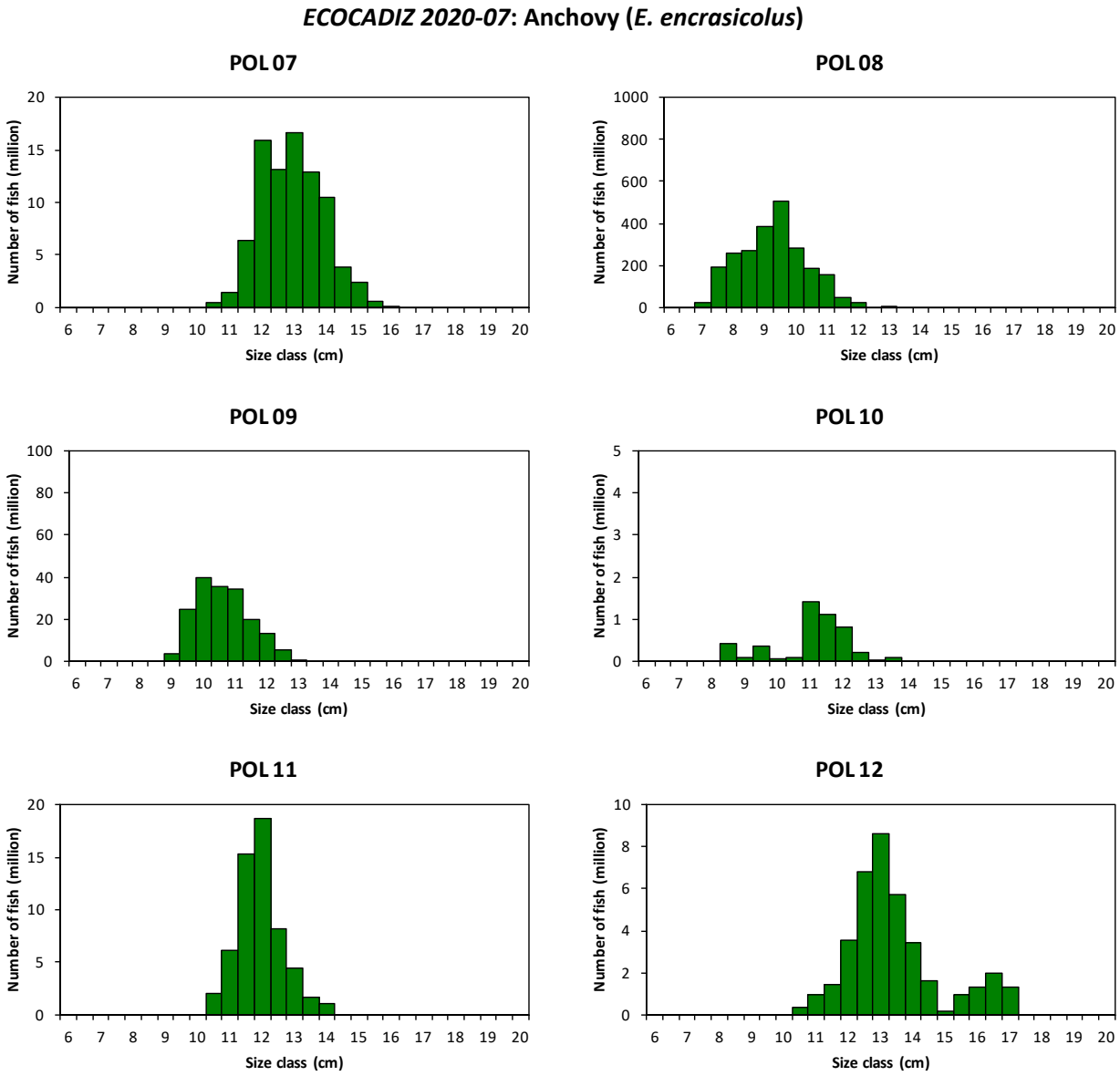


Figure 19. *ECOCADIZ 2019-07* survey. Anchovy (*E. encrasicolus*). Cont'd.

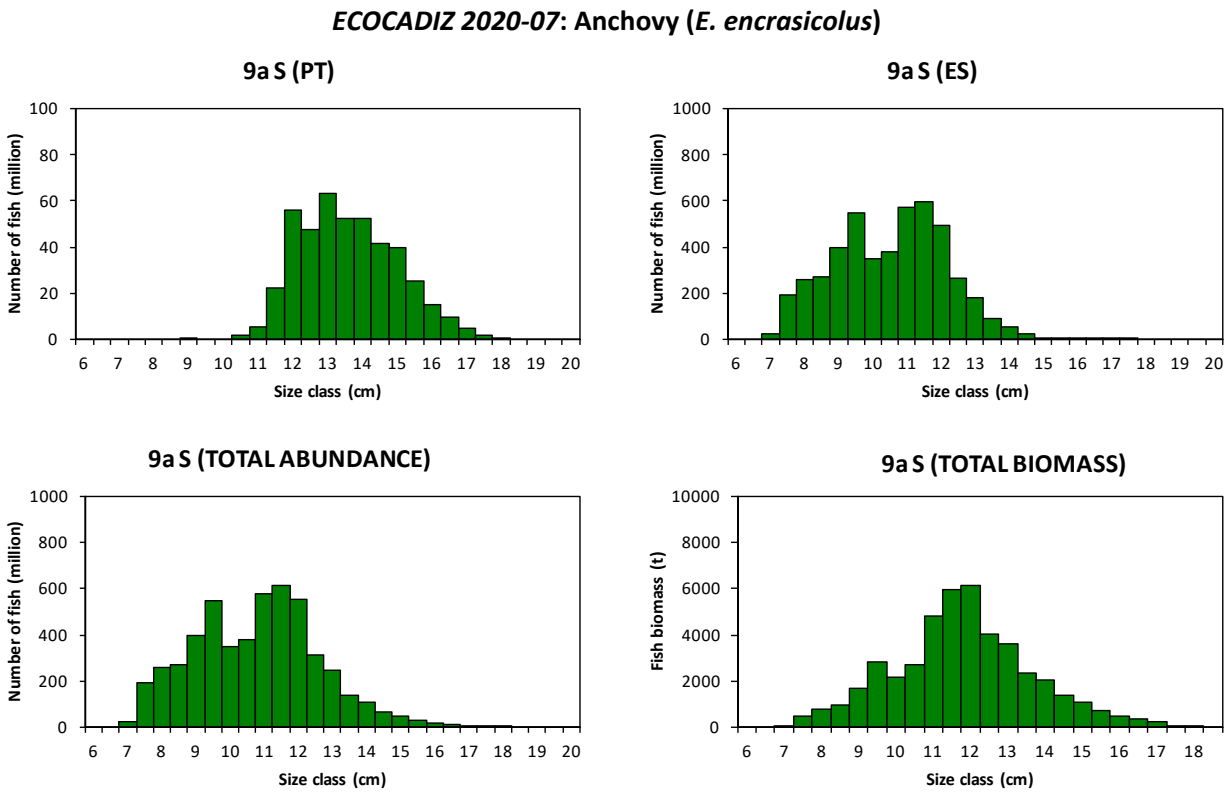


Figure 19. *ECOCADIZ 2019-07* survey. Anchovy (*E. encrasicolus*). Cont'd.

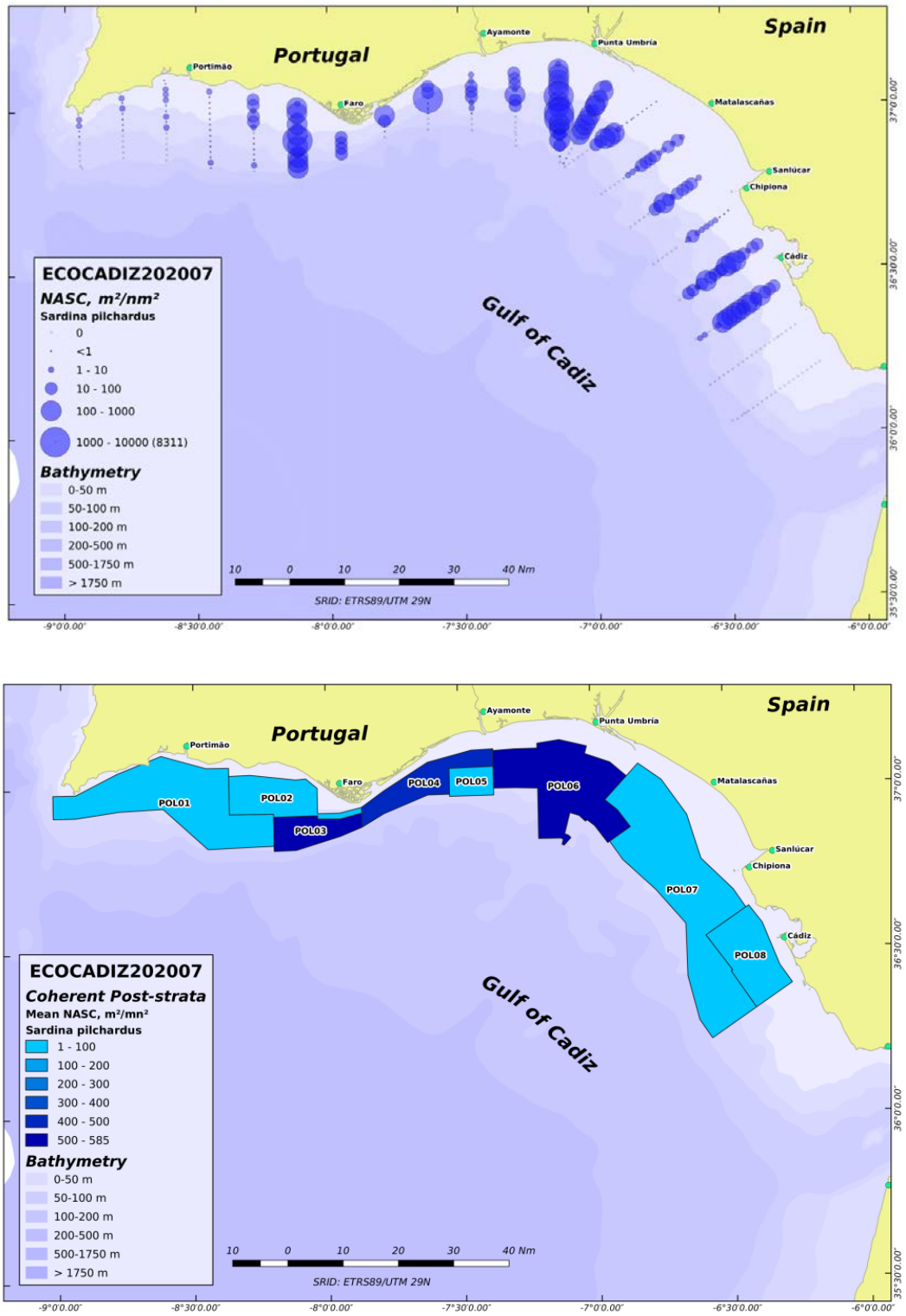


Figure 20. *ECOCADIZ 2020-07* survey. Sardine (*Sardina pilchardus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

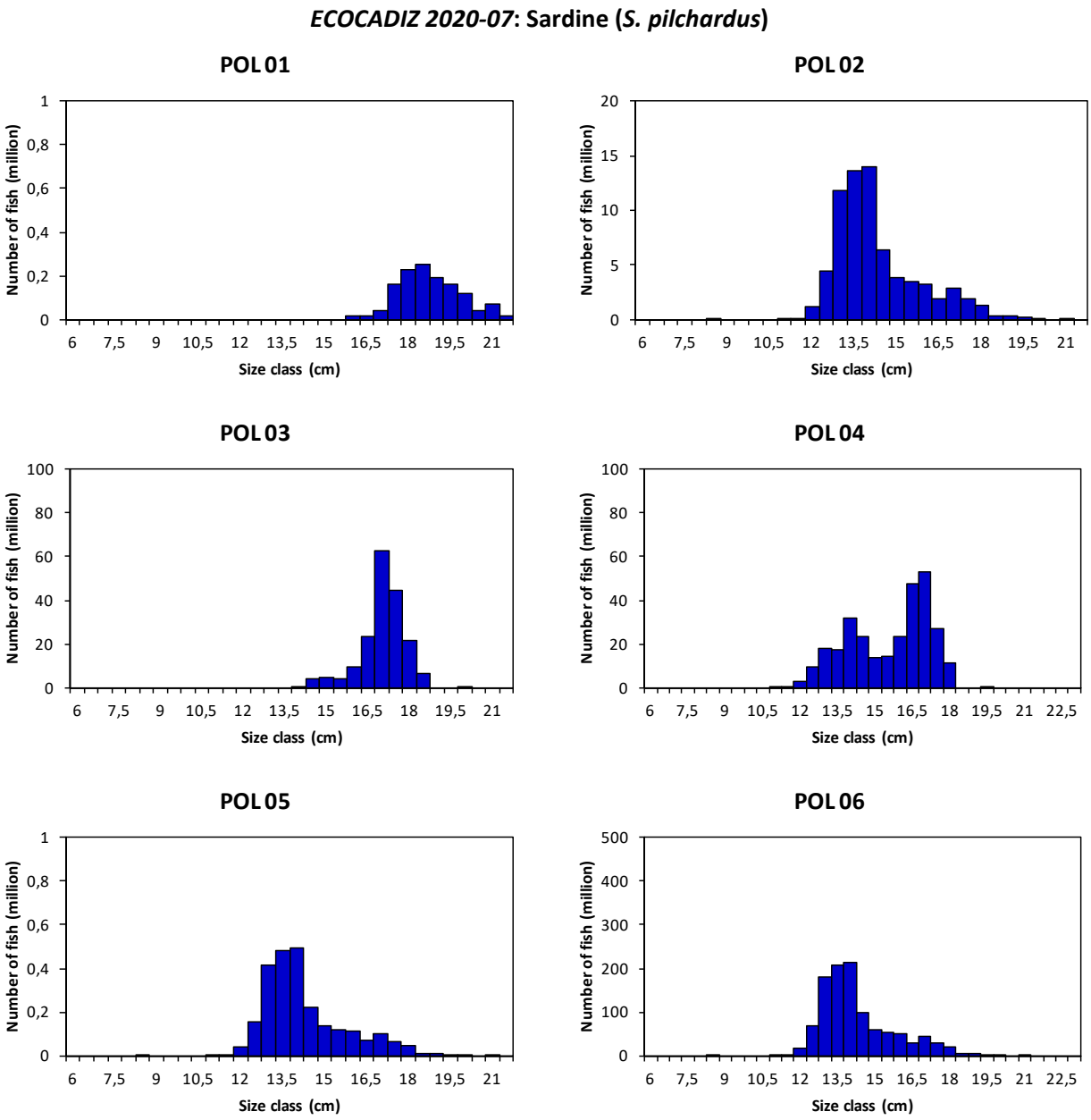


Figure 21. *ECOCADIZ 2020-07* survey. Sardine (*S. pilchardus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous stratum (POL01-POLn, numeration as in **Figure 20**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scales in the y axis.

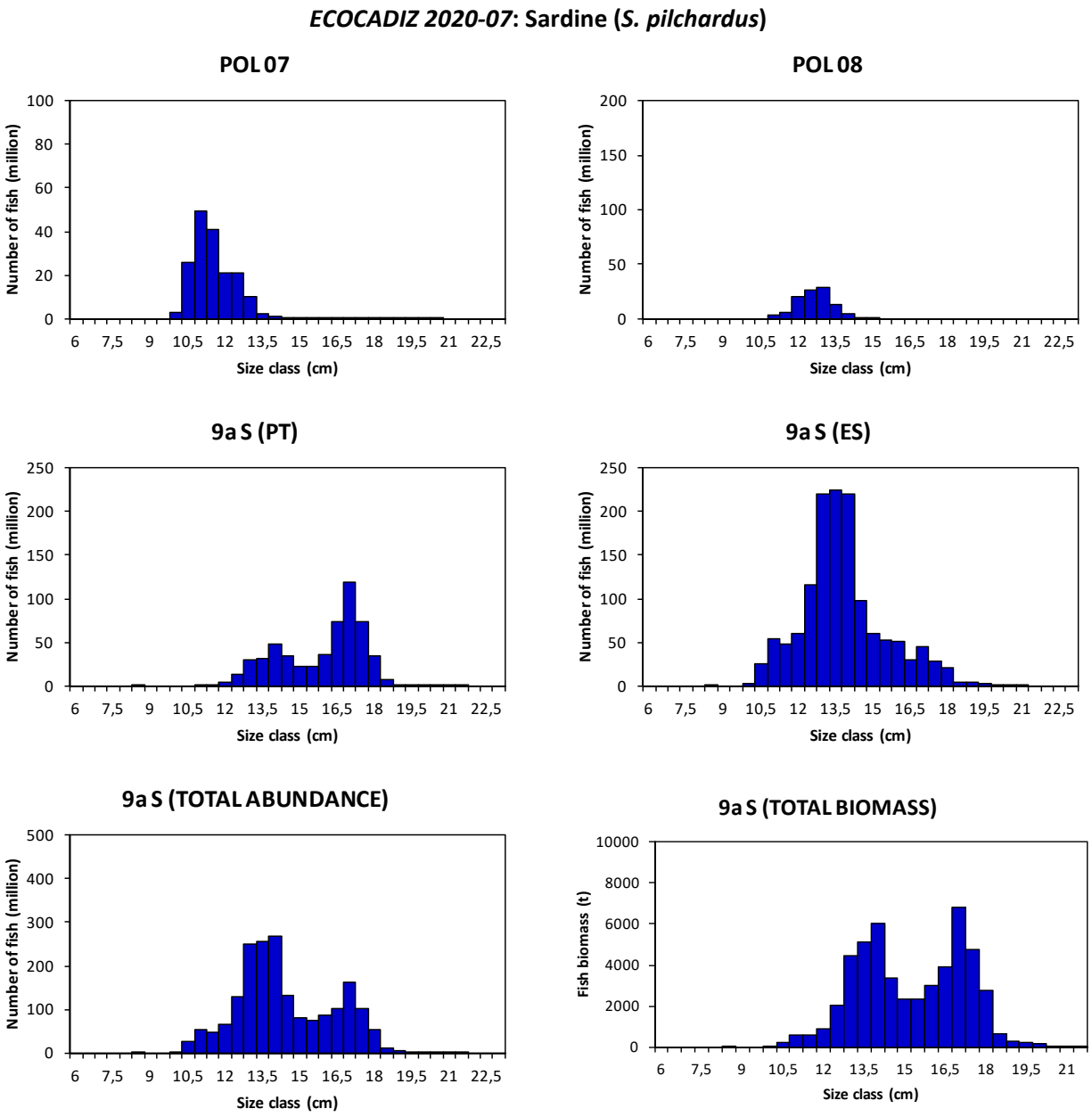


Figure 21. *ECOCADIZ 2020-07* survey. Sardine (*S. pilchardus*). Cont'd.

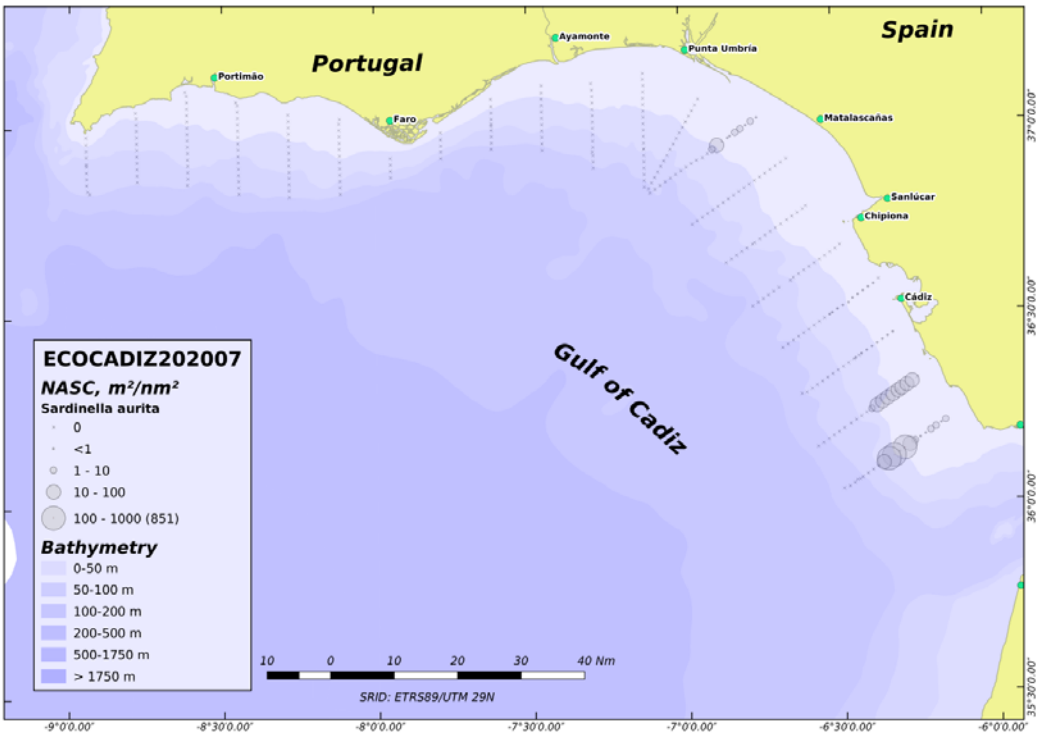


Figure 22. *ECOCADIZ 2020-07* survey. Round sardinella (*Sardinella aurita*). Distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species.

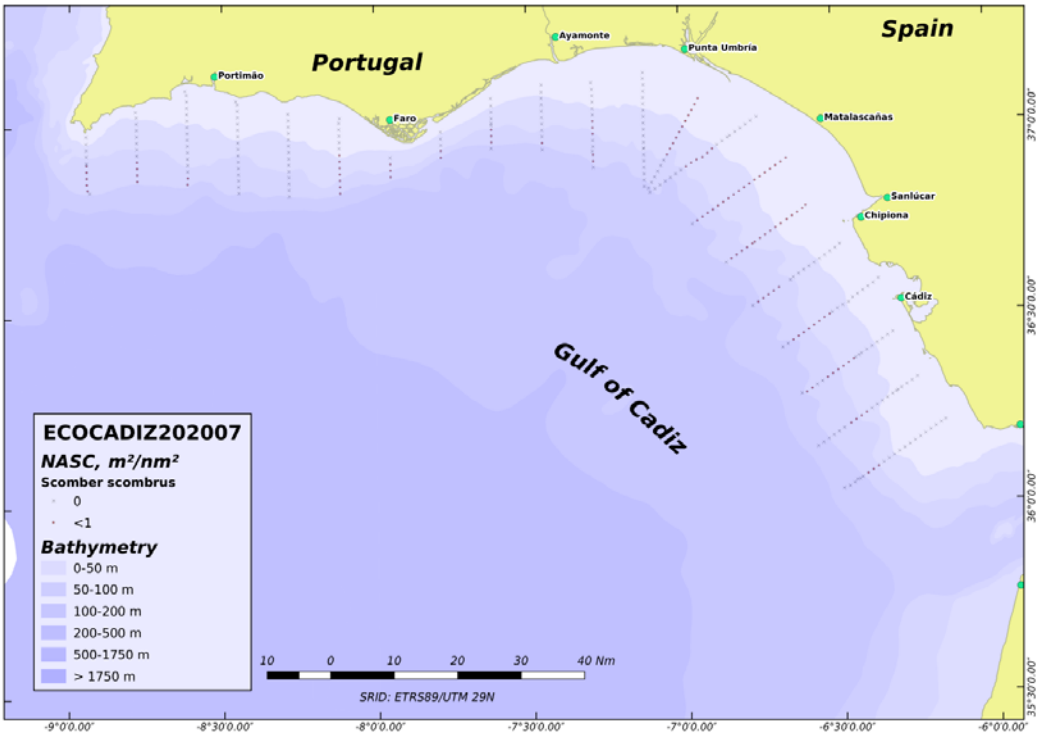


Figure 23. *ECOCADIZ 2020-07* survey. Mackerel (*Scomber scombrus*). Distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species.

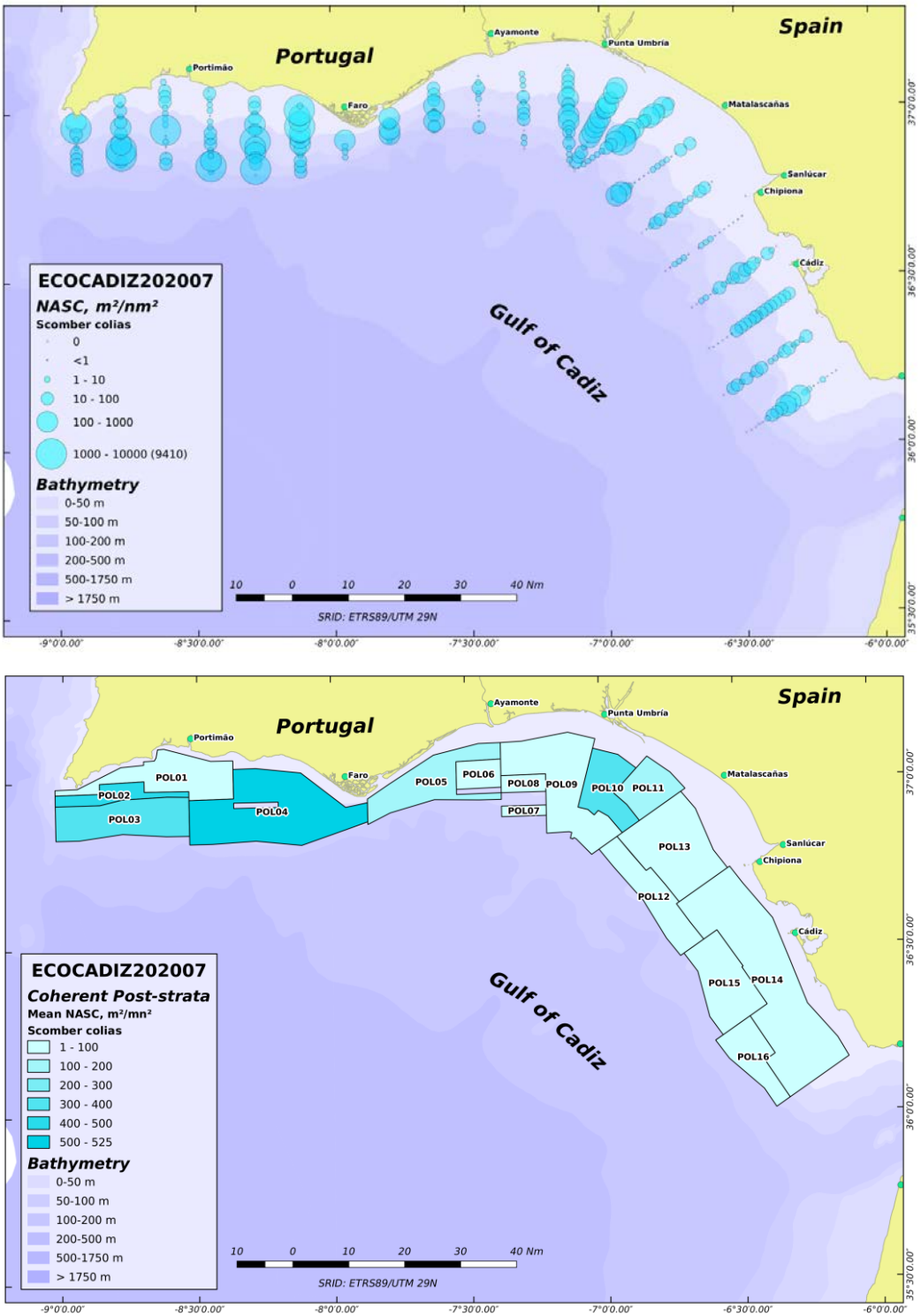


Figure 24. *ECOCADIZ 2020-07* survey. Chub mackerel (*Scomber colias*). Distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

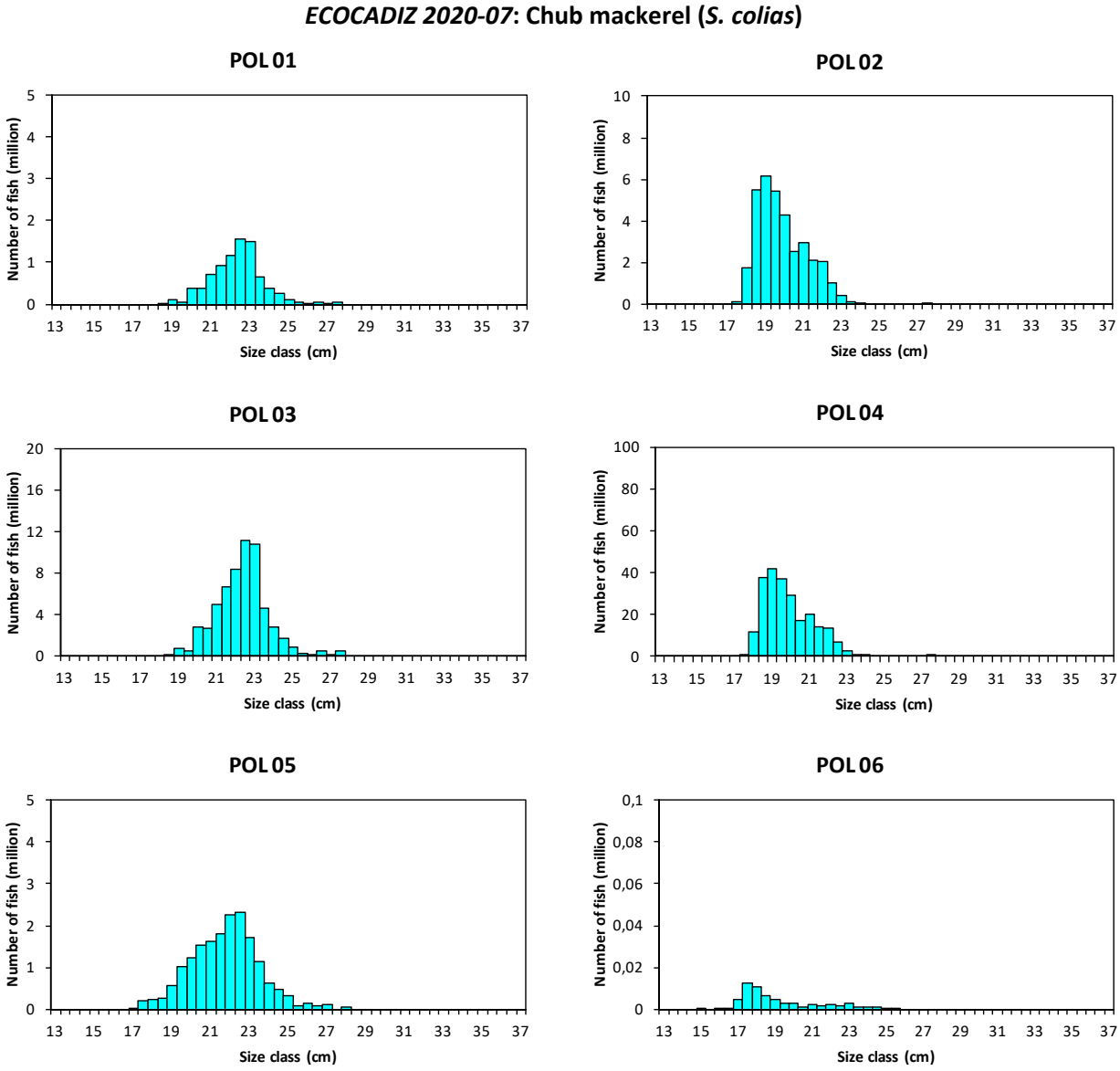


Figure 25. *ECOCADIZ 2020-07* survey. Chub mackerel (*Scomber colias*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous stratum (POL01-POLn, numeration as in **Figure 23**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scales in the y axis.

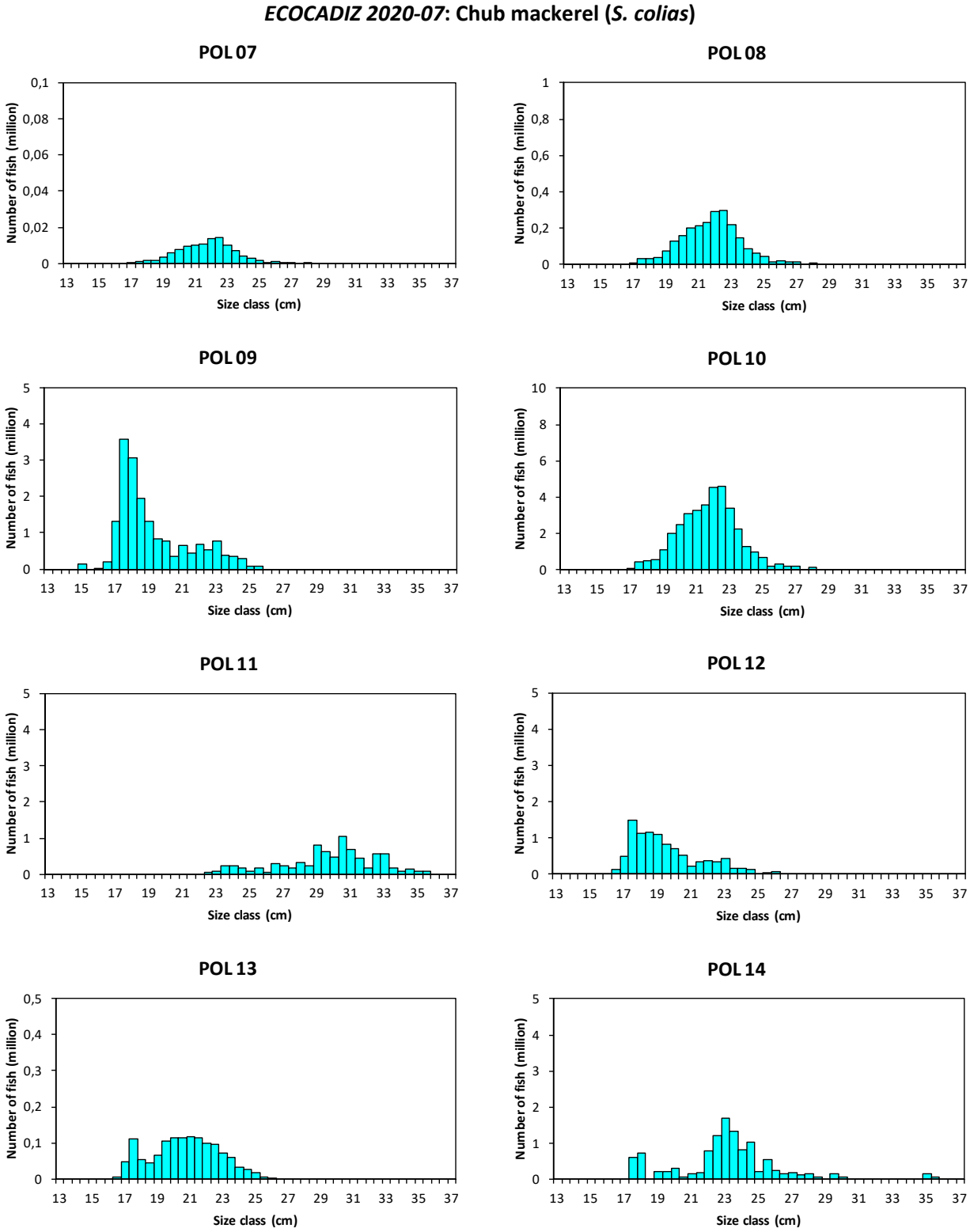


Figure 25. *ECOCADIZ 2020-07* survey. Chub mackerel (*Scomber colias*). Cont'd.

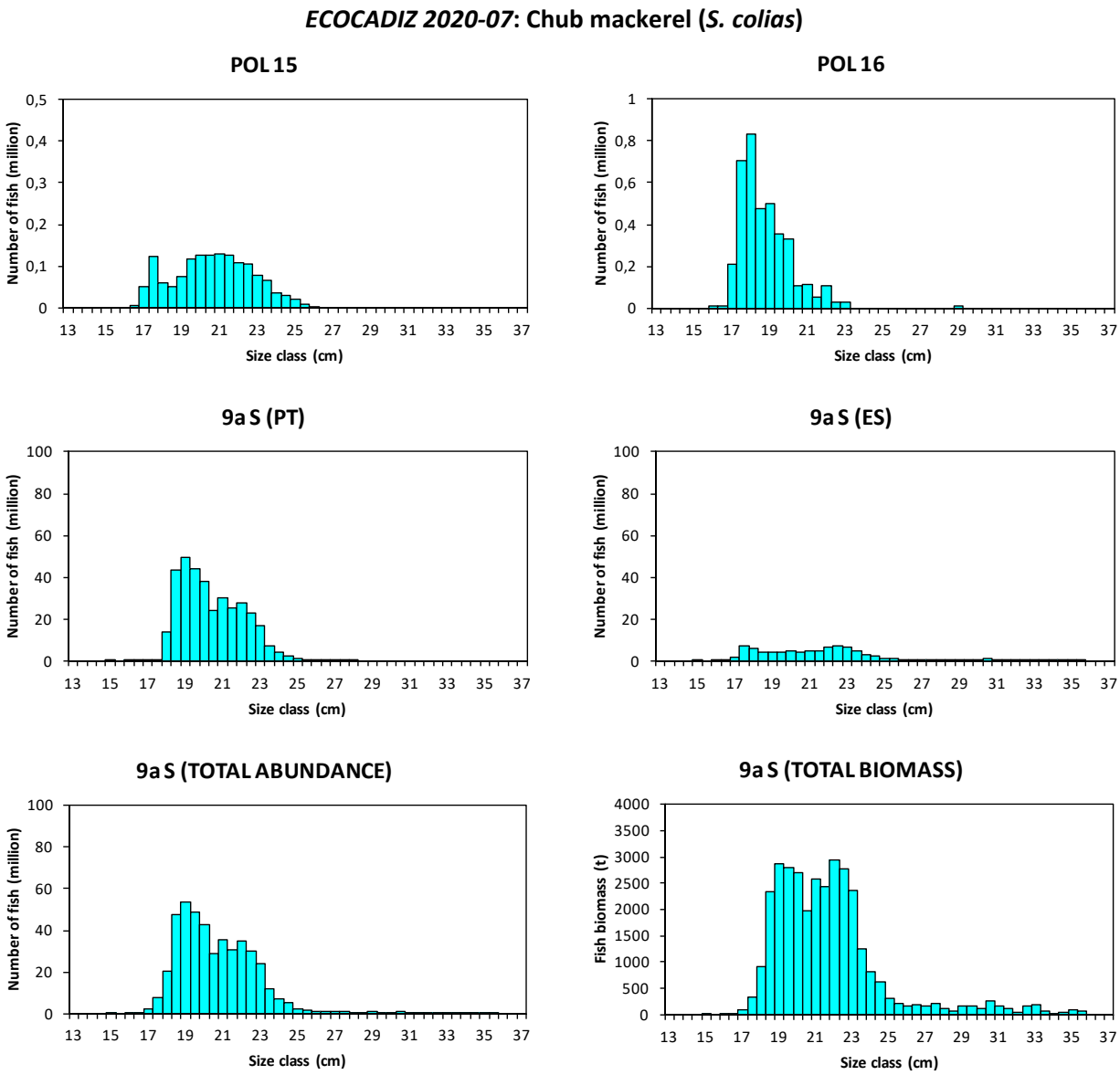


Figure 25. *ECOCADIZ 2020-07* survey. Chub mackerel (*Scomber colias*). Cont'd.

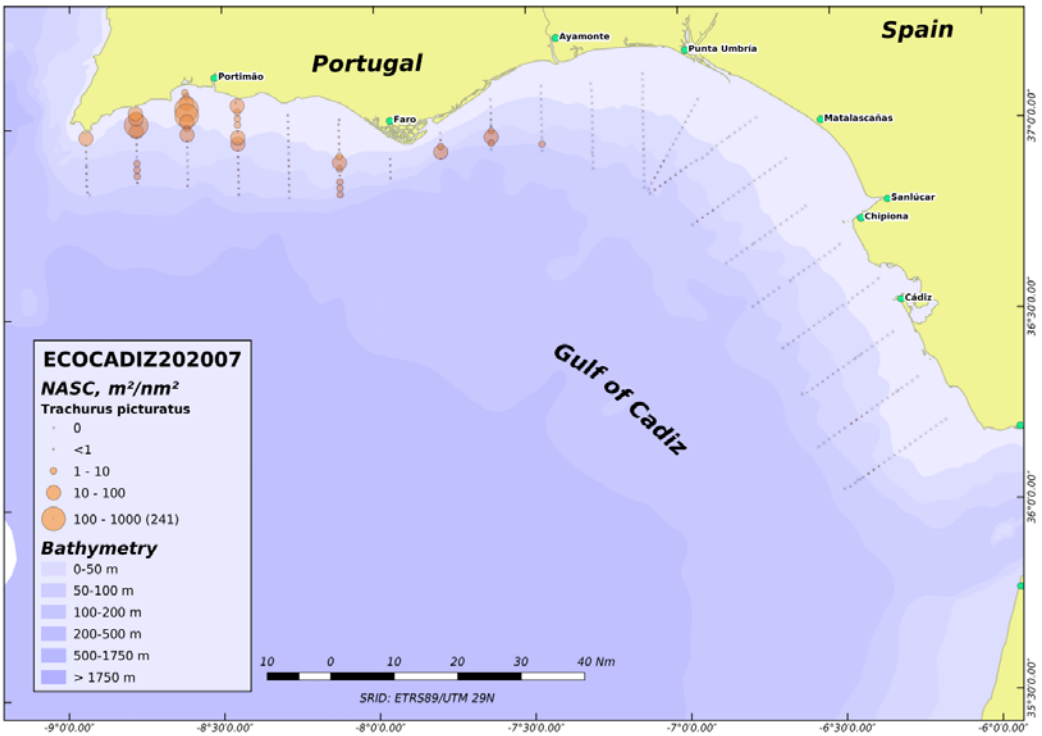


Figure 26. *ECOCADIZ 2020-07* survey. Blue jack mackerel (*Trachurus picturatus*). Distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species.

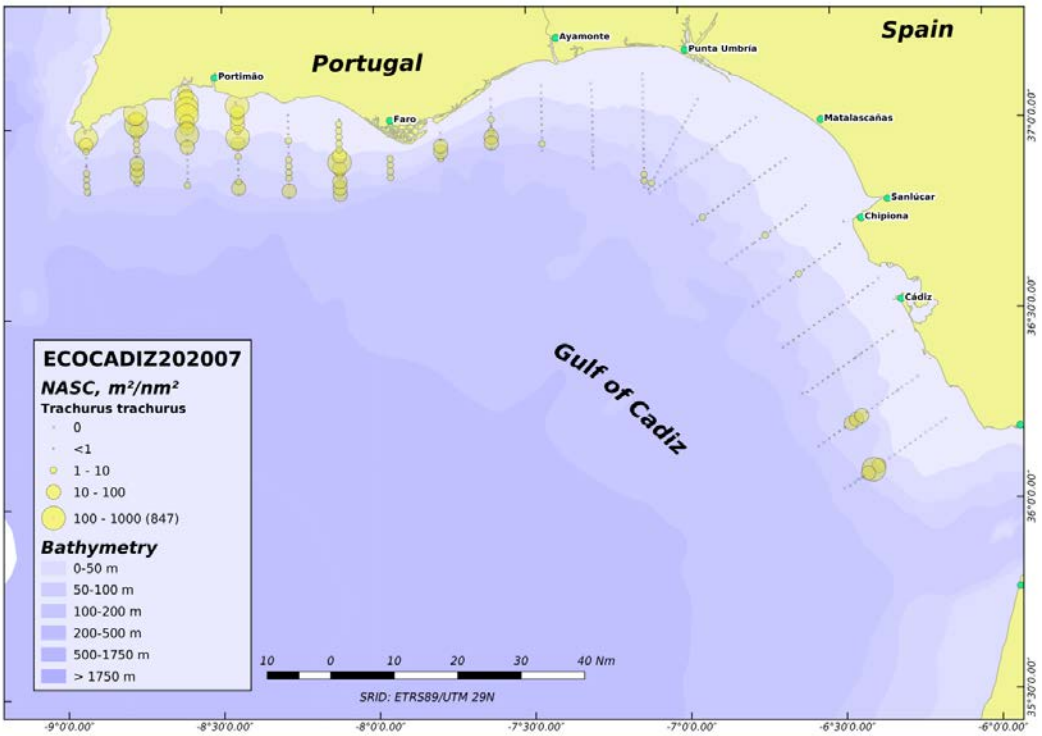


Figure 27. *ECOCADIZ 2020-07* survey. Horse mackerel (*Trachurus trachurus*). Distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species.

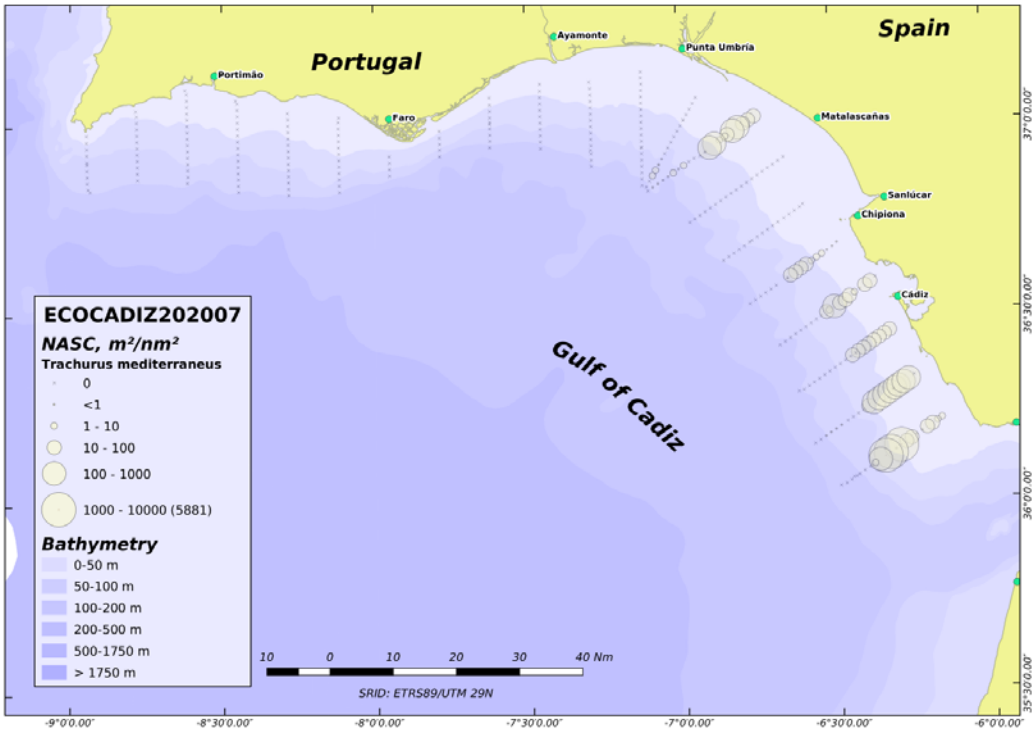


Figure 28. *ECOCADIZ 2020-07* survey. Mediterranean horse mackerel (*Trachurus mediterraneus*). Distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species.

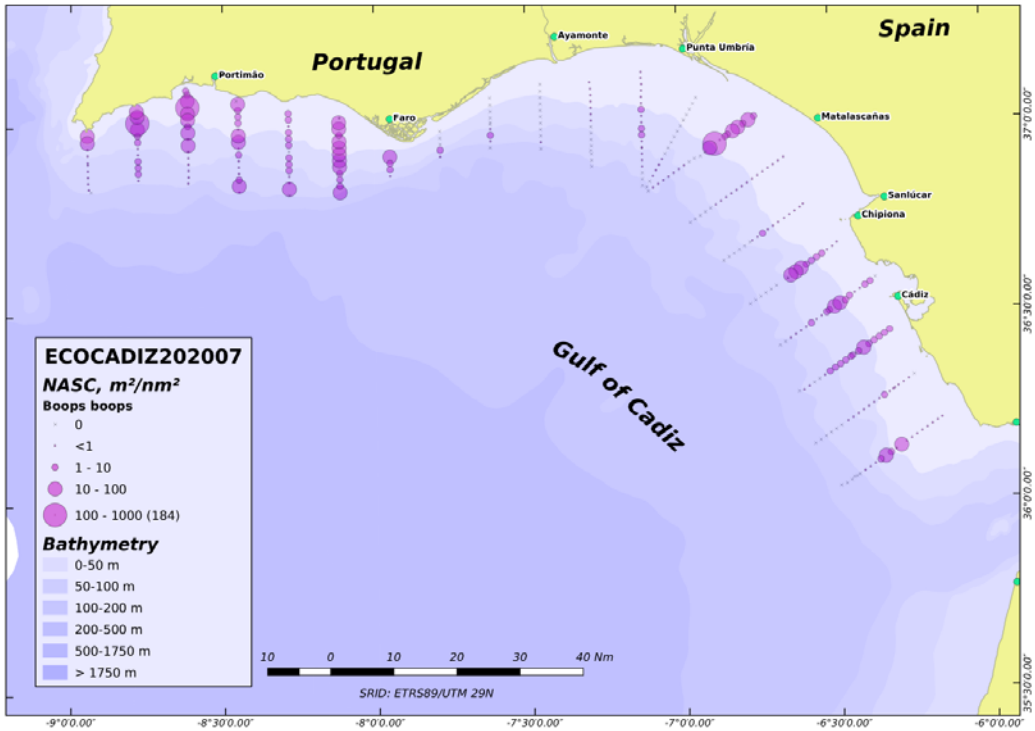


Figure 29. *ECOCADIZ 2020-07* survey. Bogue (*Boops boops*). Distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species.

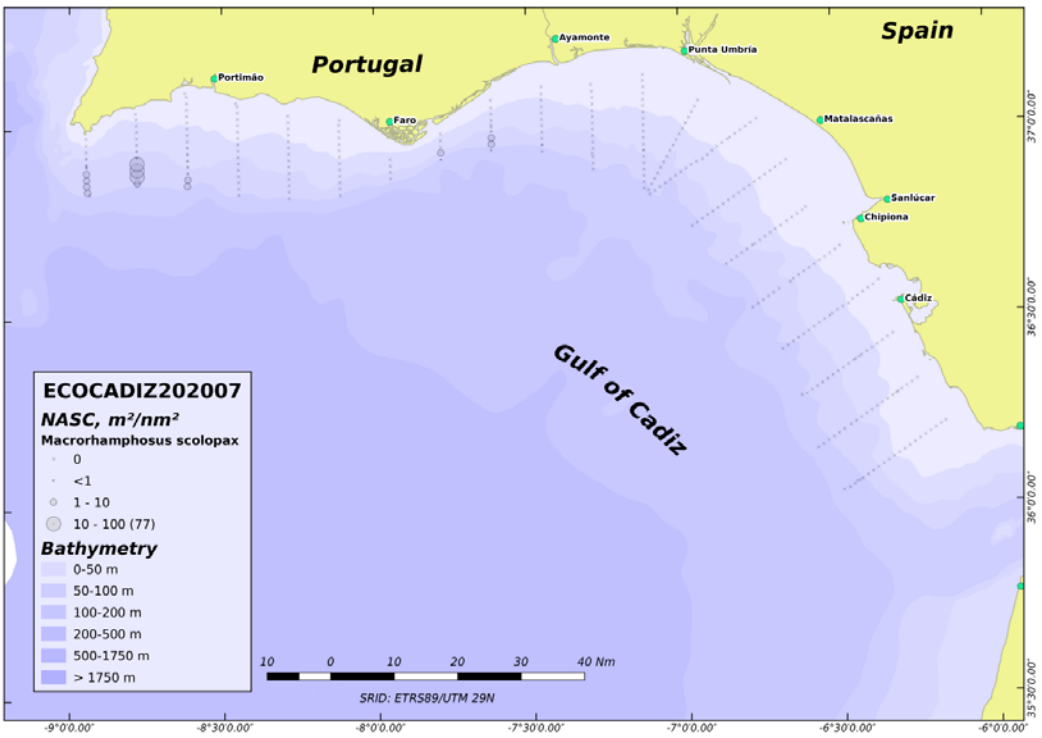


Figure 30. *ECOCADIZ 2020-07* survey. Longspine snipefish (*Macroramphosus scolopax*). Distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species.

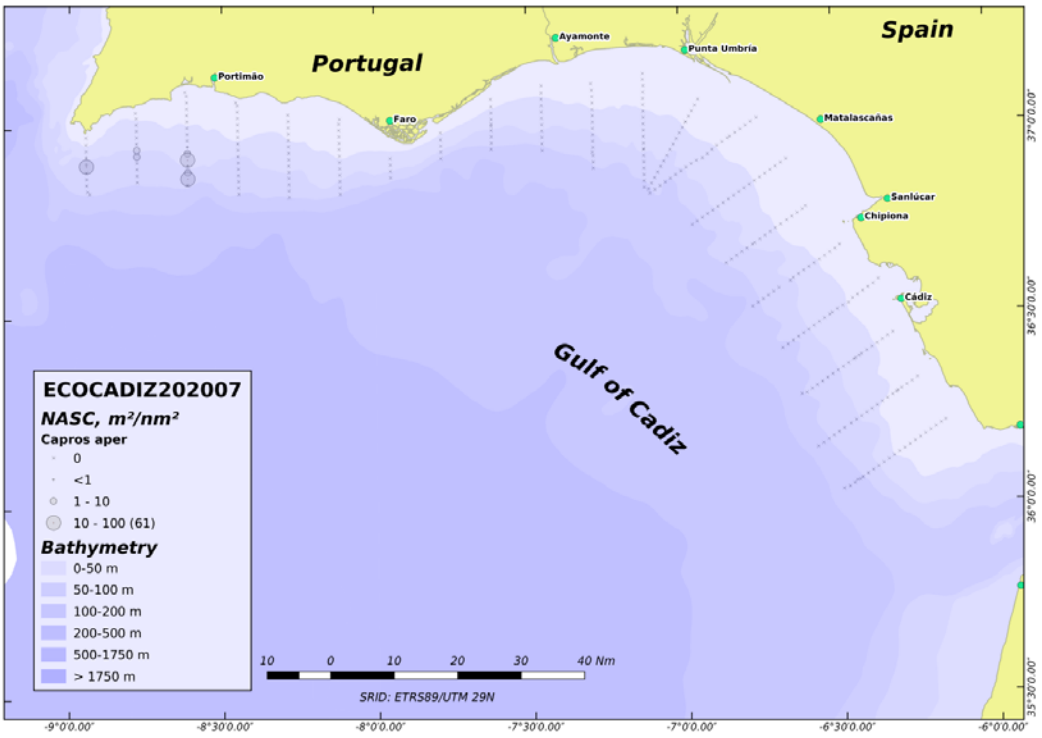


Figure 31. *ECOCADIZ 2020-07* survey. Boarfish (*Capros aper*). Distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in m^2 nmi^{-2}) attributed to the species.

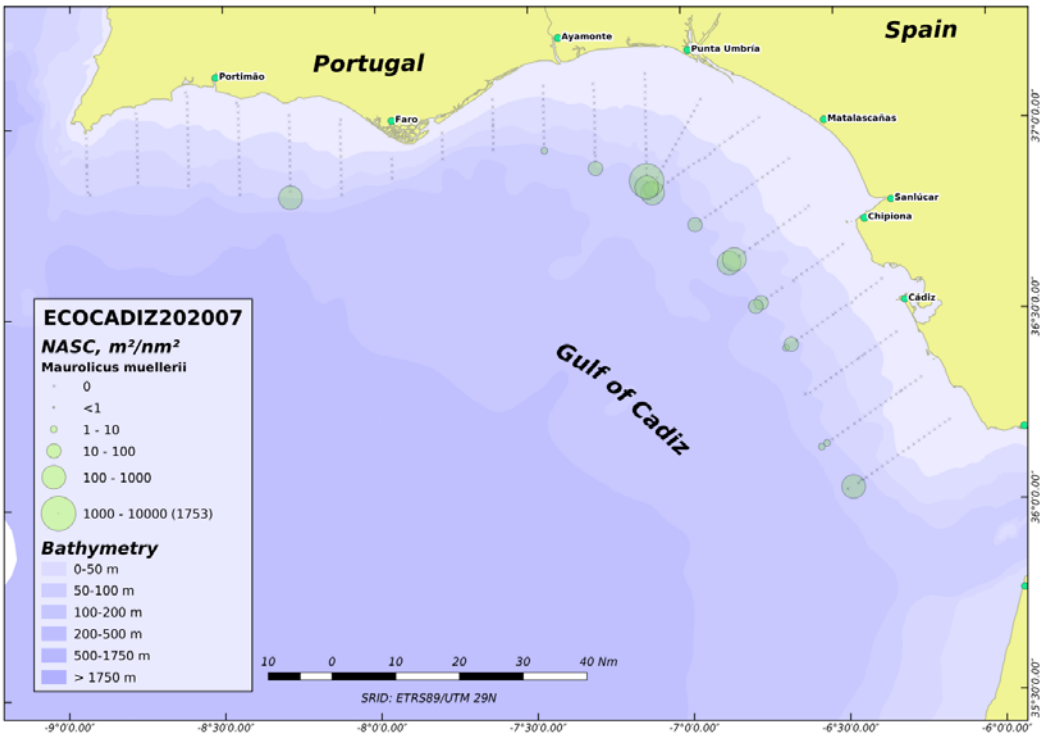


Figure 32. *ECOCADIZ 2020-07* survey. Pearlside (*Maurolicus muelleri*). Distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species.

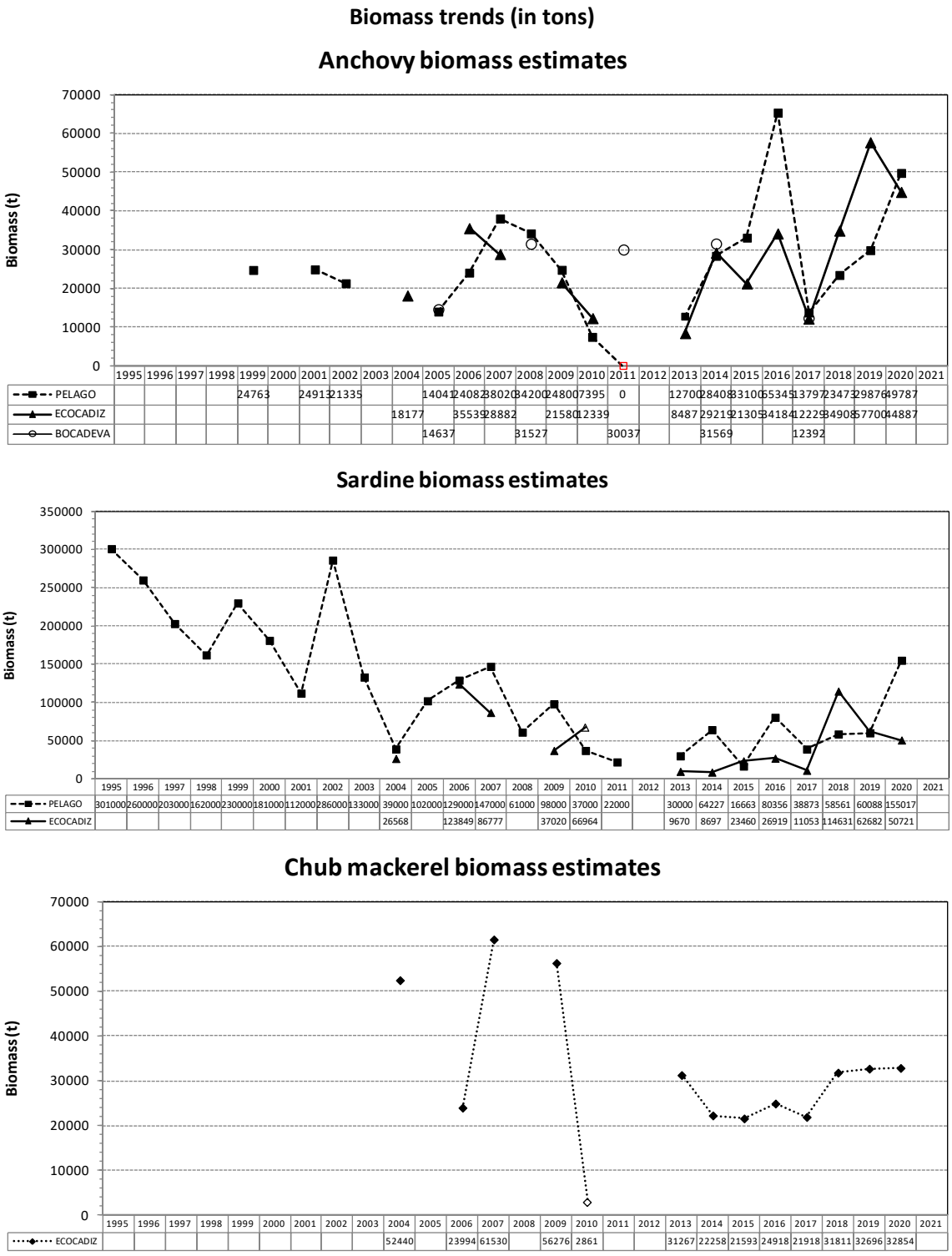


Figure 33. Trends in biomass estimates (in tons) for the main assessed species in Portuguese (*PELAGO*) and Spanish (*ECOCADIZ* and *BOCADEVA*) survey series. Note that the *ECOCADIZ* survey in 2010 partially covered the whole study area. The anchovy null estimate in 2011 from the *PELAGO* survey should be considered with caution.